MITSUBISHI ELECTRIC

Changes for the Better

MITSUBISHI CNC

Specifications Manual

MDS-D-SVJ3/SPJ3 Series

IB-1500158(ENG)-C

Introduction

Thank you for selecting the Mitsubishi numerical control unit. This instruction manual describes the handling and caution points for using this AC servo/spindle.Incorrect handling may lead to unforeseen accidents, so always read this instruction manual thoroughly to ensure correct usage.
In order to confirm if all function specifications described in this manual are applicable, refer to the specifications for each CNC.

Notes on Reading This Manual

(1) Since the description of this specification manual deals with NC in general, for the specifications of individual machine tools, refer to the manuals issued by the respective machine manufacturers. The "restrictions" and "available functions" described in the manuals issued by the machine manufacturers have precedence to those in this manual.
(2) This manual describes as many special operations as possible, but it should be kept in mind that items not mentioned in this manual cannot be performed.

Precautions for safety

Please read this manual and auxiliary documents before starting installation, operation, maintenance or inspection to ensure correct usage. Thoroughly understand the device, safety information and precautions before starting operation.
The safety precautions in this instruction manual are ranked as "WARNING" and "CAUTION".

⚠**DANGER**	When there is a potential risk of fatal or serious injuries if handling is mistaken.

⚠**WARNING**	When a dangerous situation, or fatal or serious injuries may occur if handling is mistaken.

⚠**CAUTION**	When a dangerous situation may occur if handling is mistaken leading to medium or minor injuries, or physical damage.

Note that some items described as "⚠CAUTION" may lead to major results depending on the situation. In any case, important information that must be observed is described.

The signs indicating prohibited and mandatory matters are explained below.

	Indicates a prohibited matter. For example, "Fire Prohibited" is indicated as  .
	Indicates a mandatory matter. For example, grounding is indicated as  .

The meaning of each pictorial sign is as follows.

 **CAUTION**	 **CAUTION rotated object**	 **CAUTION HOT**	 **Danger Electric shock risk**	 **Danger explosive**
 **Prohibited**	 **Disassembly is prohibited**	 **KEEP FIRE AWAY**	 **General instruction**	 **Earth ground**

After reading this specifications and instructions manual, store it where the user can access it easily for reference.

The numeric control unit is configured of the control unit, operation board, servo drive unit, spindle drive unit, power supply, servomotor and spindle motor, etc.
In this section "Precautions for safety", the following items are generically called the "motor".

- Servomotor
- Linear servomotor
- Spindle motor

In this section "Precautions for safety", the following items are generically called the "unit".

- Servo drive unit
- Spindle drive unit
- Power supply unit
- Scale interface unit
- Magnetic pole detection unit

POINT Important matters that should be understood for operation of this machine are indicated as a POINT in this manual.

⚠ WARNING

1. Electric shock prevention

- ⚠ Do not open the front cover while the power is ON or during operation. Failure to observe this could lead to electric shocks.
- ⚠ Do not operate the unit with the front cover removed. The high voltage terminals and charged sections will be exposed, and can cause electric shocks.
- ⚠ Do not remove the front cover and connector even when the power is OFF unless carrying out wiring work or periodic inspections. The inside of the units is charged, and can cause electric shocks.
- ⚠ Since the high voltage is supplied to the main circuit connector while the power is ON or during operation, do not touch the main circuit connector with an adjustment screwdriver or the pen tip. Failure to observe this could lead to electric shocks.
- ⚠ Wait at least 15 minutes after turning the power OFF, confirm that the CHARGE lamp has gone out, and check the voltage between P and N terminals with a tester, etc., before starting wiring, maintenance or inspections. Failure to observe this could lead to electric shocks.
- ⚠ Ground the unit and motor following the standards set forth by each country.
- ⚠ Wiring, maintenance and inspection work must be done by a qualified technician.
- ⚠ Wire the servo drive unit and servomotor after installation. Failure to observe this could lead to electric shocks.
- ⚠ Do not touch the switches with wet hands. Failure to observe this could lead to electric shocks.
- ⚠ Do not damage, apply forcible stress, place heavy items on the cables or get them caught. Failure to observe this could lead to electric shocks.
- ⚠ After assembling the built-in IPM spindle motor, if the rotor is rotated by hand etc., voltage occurs between the terminals of lead. Take care not to get electric shocks.

2. Injury prevention

⚠ In the system where the optical communication with CNC is executed, do not see directly the light generated from CN1A/CN1B connector of drive unit or the end of cable. When the light gets into eye, you may feel something is wrong for eye.
(The light source of optical communication corresponds to class1 defined in JISC6802 or IEC60825-1.)

⚠ The linear servomotor, direct-drive motor and built-in IPM spindle motor uses permanent magnets in the rotor, so observe the following precautions.

(1)Handling

- The linear servomotor, direct-drive motor and built-in IPM spindle motor could adversely affect medical electronics such as pacemakers, etc., therefore, do not approach the rotor.
- Do not place magnetic materials as iron.
- When a magnetic material as iron is placed, take safety measure not to pinch fingers or hands due to the magnetic attraction force.
- Remove metal items such as watch, piercing jewelry, necklace, etc.
- Do not place portable items that could malfunction or fail due to the influence of the magnetic force.
- When the rotor is not securely fixed to the machine or device, do not leave it unattended but store it in the package properly.

(2)Transportation and storage

- Correctly store the rotor in the package to transport and store.
- During transportation and storage, draw people's attention by applying a notice saying "Strong magnet-Handle with care" to the package or storage shelf.
- Do not use a damaged package.

(3)Installation

- Take special care not to pinch fingers, etc., when installing (and unpacking) the linear servomotor.

⚠ CAUTION

1. Fire prevention

- ⚠ Install the units, motors and regenerative resistor on non-combustible material. Direct installation on combustible material or near combustible materials could lead to fires.
- ⚠ Always install a circuit protector and contactor on the servo drive unit power input as explained in this manual. Refer to this manual and select the correct circuit protector and contactor. An incorrect selection could result in fire.
- ⚠ Shut off the power on the unit side if a fault occurs in the units. Fires could be caused if a large current continues to flow.
- ⚠ When using a regenerative resistor, provide a sequence that shuts off the power with the regenerative resistor's error signal. The regenerative resistor could abnormally overheat and cause a fire due to a fault in the regenerative transistor, etc.
- ⚠ The battery unit could heat up, ignite or rupture if submerged in water, or if the poles are incorrectly wired.
- ⚠ Cut off the main circuit power with the contactor when an alarm or emergency stop occurs.

2. Injury prevention

- ⚠ Do not apply a voltage other than that specified in this manual, on each terminal. Failure to observe this item could lead to ruptures or damage, etc.
- ⚠ Do not mistake the terminal connections. Failure to observe this item could lead to ruptures or damage, etc.
- ⚠ Do not mistake the polarity (+,-). Failure to observe this item could lead to ruptures or damage, etc.
- ⚠ Do not touch the radiation fin on unit back face, regenerative resistor or motor, etc., or place parts (cables, etc.) while the power is turned ON or immediately after turning the power OFF. These parts may reach high temperatures, and can cause burns or part damage.
- ⚠ Structure the cooling fan on the unit back face, etc., etc so that it cannot be touched after installation. Touching the cooling fan during operation could lead to injuries.

⚠ CAUTION

3. Various precautions

Observe the following precautions. Incorrect handling of the unit could lead to faults, injuries and electric shocks, etc.

(1) Transportation and installation

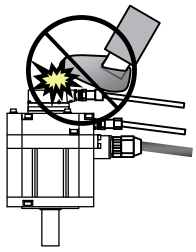
⚠ Correctly transport the product according to its weight.

❗ Use the motor's hanging bolts only when transporting the motor. Do not transport the machine when the motor is installed on the machine.

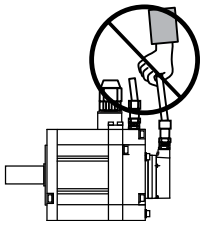
⚠ Do not stack the products above the tolerable number.

⚠ Follow this manual and install the unit or motor in a place where the weight can be borne.

⚠ Do not get on top of or place heavy objects on the unit.



⚠ Do not hold the cables, axis or detector when transporting the motor.



⚠ Do not hold the connected wires or cables when transporting the units.

⚠ Do not hold the front cover when transporting the unit. The unit could drop.

⚠ Always observe the installation directions of the units or motors.

⚠ Secure the specified distance between the units and control panel, or between the servo drive unit and other devices.

⚠ Do not install or run a unit or motor that is damaged or missing parts.

⚠ Do not block the intake or exhaust ports of the motor provided with a cooling fan.

⚠ Do not let foreign objects enter the units or motors. In particular, if conductive objects such as screws or metal chips, etc., or combustible materials such as oil enter, rupture or breakage could occur.

⚠ Provide adequate protection using a material such as connector for conduit to prevent screws, metallic detritus, water and other conductive matter or oil and other combustible matter from entering the motor through the power line lead-out port.

⚠ The units, motors and detectors are precision devices, so do not drop them or apply strong impacts to them.

⚠ CAUTION

⚠ Store and use the units under the following environment conditions.

Environment	Unit	Motor
Ambient temperature	Operation: 0 to 55°C(with no freezing), Storage / Transportation: -15°C to 70°C (with no freezing)	Operation: 0 to 40°C(with no freezing), Storage: -15°C to 70°C (Note2) (with no freezing)
Ambient humidity	Operation: 90%RH or less (with no dew condensation) Storage / Transportation: 90%RH or less (with no dew condensation)	Operation: 80%RH or less (with no dew condensation), Storage: 90%RH or less (with no dew condensation)
Atmosphere	Indoors (no direct sunlight) With no corrosive gas, inflammable gas, oil mist, dust or conductive fine particles	
Altitude	Operation/Storage: 1000 meters or less above sea level, Transportation: 13000 meters or less above sea level	Operation: 1000 meters or less above sea level, Storage: 10000 meters or less above sea level
Vibration/impact	According to each unit or motor specification	

(Note 1) For details, confirm each unit or motor specifications in addition.
(Note 2) -15°C to 55°C for linear servomotor.

⚠ Securely fix the servomotor to the machine. Insufficient fixing could lead to the servomotor slipping off during operation.

⚠ Always install the servomotor with reduction gear in the designated direction. Failure to do so could lead to oil leaks.

⚠ Structure the rotary sections of the motor so that it can never be touched during operation. Install a cover, etc., on the shaft.

⚠ When installing a coupling to a servomotor shaft end, do not apply an impact by hammering, etc. The detector could be damaged.

⚠ Do not apply a load exceeding the tolerable load onto the servomotor shaft. The shaft could break.

⚠ Store the motor in the package box.

⚠ When inserting the shaft into the built-in IPM spindle motor, do not heat the rotor higher than 130°C. The magnet could be demagnetized, and the specifications characteristics will not be ensured.

⚠ Always use a nonmagnetic tool (explosion-proof beryllium copper alloy safety tool: NGK Insulators, etc.) when installing the linear servomotor.

⚠ Always provide a mechanical stopper on the end of the linear servomotor's travel path.

❗ If the unit has been stored for a long time, always check the operation before starting actual operation. Please contact the Service Center, Service Station, Sales Office or delayer.

(2) Wiring

⚠ Correctly and securely perform the wiring. Failure to do so could lead to abnormal operation of the motor.

⚠ Do not install a condensing capacitor, surge absorber or radio noise filter on the output side of the drive unit.

⚠ Correctly connect the output side of the drive unit (terminals U, V, W). Failure to do so could lead to abnormal operation of the motor.

⚠ When using a power regenerative power supply unit, always install an AC reactor for each power supply unit.

⚠ In the main circuit power supply side of the unit, always install an appropriate circuit protector or contactor for each unit. Circuit protector or contactor cannot be shared by several units.

⚠ CAUTION

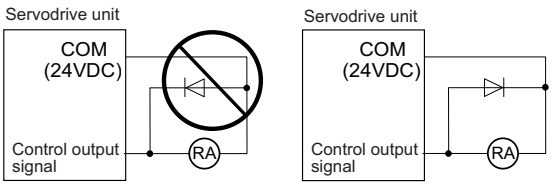
⚠ Always connect the motor to the drive unit's output terminals (U, V, W).

⚠ Do not directly connect a commercial power supply to the servomotor. Failure to observe this could result in a fault.

⚠ When using an inductive load such as a relay, always connect a diode as a noise measure parallel to the load.

⚠ When using a capacitance load such as a lamp, always connect a protective resistor as a noise measure serial to the load.

⚠ Do not reverse the direction of a diode which connect to a DC relay for the control output signals such as contractor and motor brake output, etc. to suppress a surge. Connecting it backwards could cause the drive unit to malfunction so that signals are not output, and emergency stop and other safety circuits are inoperable.



⚠ Do not connect/disconnect the cables connected between the units while the power is ON.

⚠ Securely tighten the cable connector fixing screw or fixing mechanism. An insecure fixing could cause the cable to fall off while the power is ON.

⚠ When using a shielded cable instructed in the instruction manual, always ground the cable with a cable clamp, etc.

⚠ Always separate the signals wires from the drive wire and power line.

⚠ Use wires and cables that have a wire diameter, heat resistance and flexibility that conforms to the system.

(3) Trial operation and adjustment

⚠ Check and adjust each program and parameter before starting operation. Failure to do so could lead to unforeseen operation of the machine.

⚠ Do not make remarkable adjustments and changes of parameter as the operation could become unstable.

⚠ The usable motor and unit combination is predetermined. Always check the models before starting trial operation.

⚠ The linear servomotor does not have a stopping device such as magnetic brakes. Install a stopping device on the machine side.

⚠ CAUTION

(4) Usage methods

- In abnormal state, install an external emergency stop circuit so that the operation can be stopped and power shut off immediately.
- Turn the power OFF immediately if smoke, abnormal noise or odors are generated from the unit or motor.
- Do not disassemble or repair this product.
- Never make modifications.
- When an alarm occurs, the machine will start suddenly if an alarm reset (RST) is carried out while an operation start signal (ST) is being input. Always confirm that the operation signal is OFF before carrying out an alarm reset. Failure to do so could lead to accidents or injuries.
- Reduce magnetic damage by installing a noise filter. The electronic devices used near the unit could be affected by magnetic noise. Install a line noise filter, etc., if there is a risk of magnetic noise.
- Use the unit, motor and regenerative resistor with the designated combination. Failure to do so could lead to fires or trouble.
- The brake (magnetic brake) of the servomotor are for holding, and must not be used for normal braking.
- There may be cases when holding is not possible due to the magnetic brake's life, the machine construction (when ball screw and servomotor are coupled via a timing belt, etc.) or the magnetic brake's failure. Install a stop device to ensure safety on the machine side.
- After changing the programs/parameters or after maintenance and inspection, always test the operation before starting actual operation.
- Do not enter the movable range of the machine during automatic operation. Never place body parts near or touch the spindle during rotation.
- Follow the power supply specification conditions given in each specification for the power (input voltage, input frequency, tolerable sudden power failure time, etc.).
- Set all bits to "0" if they are indicated as not used or empty in the explanation on the bits.
- Do not use the dynamic brakes except during the emergency stop. Continued use of the dynamic brakes could result in brake damage.
- If a circuit protector for the main circuit power supply is shared by several units, the circuit protector may not activate when a short-circuit fault occurs in a small capacity unit. This is dangerous, so never share the circuit protector.

⚠ CAUTION

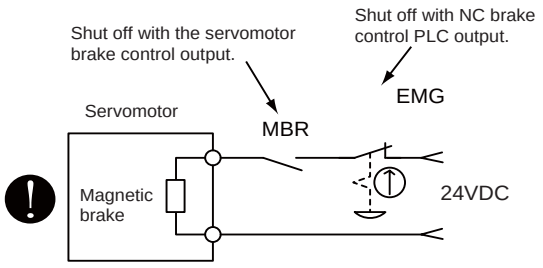
(5) Troubleshooting

⚠ If a hazardous situation is predicted during power failure or product trouble, use a servomotor with magnetic brakes or install an external brake mechanism.

⚠ Use a double circuit configuration that allows the operation circuit for the magnetic brakes to be operated even by the external emergency stop signal.

⚠ Always turn the main circuit power of the motor OFF when an alarm occurs.

⚠ If an alarm occurs, remove the cause, and secure the safety before resetting the alarm.



(6) Maintenance, inspection and part replacement

⚠ Always backup the programs and parameters before starting maintenance or inspections.

⚠ The capacity of the electrolytic capacitor will drop over time due to self-discharging, etc. To prevent secondary disasters due to failures, replacing this part every five years when used under a normal environment is recommended. Contact the Service Center, Service Station, Sales Office or delayer for repairs or part replacement.

⚠ Do not perform a megger test (insulation resistance measurement) during inspections.

❗ If the battery low warning is issued, back up the machining programs, tool data and parameters with an input/output unit, and then replace the battery.

⚠ Do not short circuit, charge, overheat, incinerate or disassemble the battery.

⚠ For after-purchase servicing of the built-in motor (including the detector), supplies of servicing parts and repairs can only be offered.

⚠ For maintenance, part replacement, and services in case of failures in the built-in motor (including the detector), take necessary actions at your end. For spindle drive unit, Mitsubishi can offer the after-purchase servicing as with the general spindle drive unit.

⚠ When a failure has occurred in the built-in motor (including the detector), some period of time can be required to supply the servicing parts or repair. Prepare the spare parts at your end whenever possible.

(7) Disposal

⚠ Take the batteries and backlights for LCD, etc., off from the controller, drive unit and motor, and dispose of them as general industrial wastes.

⚠ Do not disassemble the unit or motor.

⚠ Dispose of the battery according to local laws.

⚠ Always return the secondary side (magnet side) of the linear servomotor to the Service Center or Service Station.

⚠ When incinerating optical communication cable, hydrogen fluoride gas or hydrogen chloride gas which is corrosive and harmful may be generated. For disposal of optical communication cable, request for specialized industrial waste disposal services that has incineration facility for disposing hydrogen fluoride gas or hydrogen chloride gas.

⚠ CAUTION

(8) Transportation

⚠ The unit and motor are precision parts and must be handled carefully.

⚠ According to a United Nations Advisory, the battery unit and battery must be transported according to the rules set forth by the International Civil Aviation Organization (ICAO), International Air Transportation Association (IATA), International Maritime Organization (IMO), and United States Department of Transportation (DOT), etc.

(9) General precautions

The drawings given in this manual show the covers and safety partitions, etc., removed to provide a clearer explanation. Always return the covers or partitions to their respective places before starting operation, and always follow the instructions given in this manual.

Treatment of waste

The following two laws will apply when disposing of this product. Considerations must be made to each law. The following laws are in effect in Japan. Thus, when using this product overseas, the local laws will have a priority. If necessary, indicate or notify these laws to the final user of the product.

(1) Requirements for "Law for Promotion of Effective Utilization of Resources"
   (a) Recycle as much of this product as possible when finished with use.
   (b) When recycling, often parts are sorted into steel scraps and electric parts, etc., and sold to scrap contractors. Mitsubishi recommends sorting the product and selling the members to appropriate contractors.

(2) Requirements for "Law for Treatment of Waste and Cleaning"
   (a) Mitsubishi recommends recycling and selling the product when no longer needed according to item (1) above. The user should make an effort to reduce waste in this manner.
   (b) When disposing a product that cannot be resold, it shall be treated as a waste product.
   (c) The treatment of industrial waste must be commissioned to a licensed industrial waste treatment contractor, and appropriate measures, including a manifest control, must be taken.
   (d) Batteries correspond to "primary batteries", and must be disposed of according to local disposal laws.

Disposal

(Note) This symbol mark is for EU countries only.
This symbol mark is according to the directive 2006/66/EC Article 20 Information for end-users and Annex II.

Your MITSUBISHI ELECTRIC product is designed and manufactured with high quality materials and components which can be recycled and/or reused.
This symbol means that batteries and accumulators, at their end-of-life, should be disposed of separately from your household waste.
If a chemical symbol is printed beneath the symbol shown above, this chemical symbol means that the battery or accumulator contains a heavy metal at a certain concentration. This will be indicated as follows:
Hg: mercury (0,0005%), Cd: cadmium (0,002%), Pb: lead (0,004%)
In the European Union there are separate collection systems for used batteries and accumulators.
Please, dispose of batteries and accumulators correctly at your local community waste collection/ recycling centre.

Please, help us to conserve the environment we live in!

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Appendix 4 EMC Installation Guidelines ...Appendix 4 - 1

Outline for MDS-D-SVJ3/SPJ3 Series Instruction Manual (IB-1500193-D)

1 Installation

2 Wiring and Connection

3 Setup

4 Servo Adjustment

5 Spindle Adjustment

6 Troubleshooting

7 Maintenance

Appendix 1 Cable and Connector Specifications

Appendix 2 Cable and Connector Assembly

Appendix 3 Precautions in Installing Spindle Motor

Appendix 4 Compliance to EC Directives

Appendix 5 EMC Installation Guidelines

Appendix 6 EC Declaration of Conformity

Appendix 7 Higher Harmonic Suppression Measure Guidelines

1

Introduction

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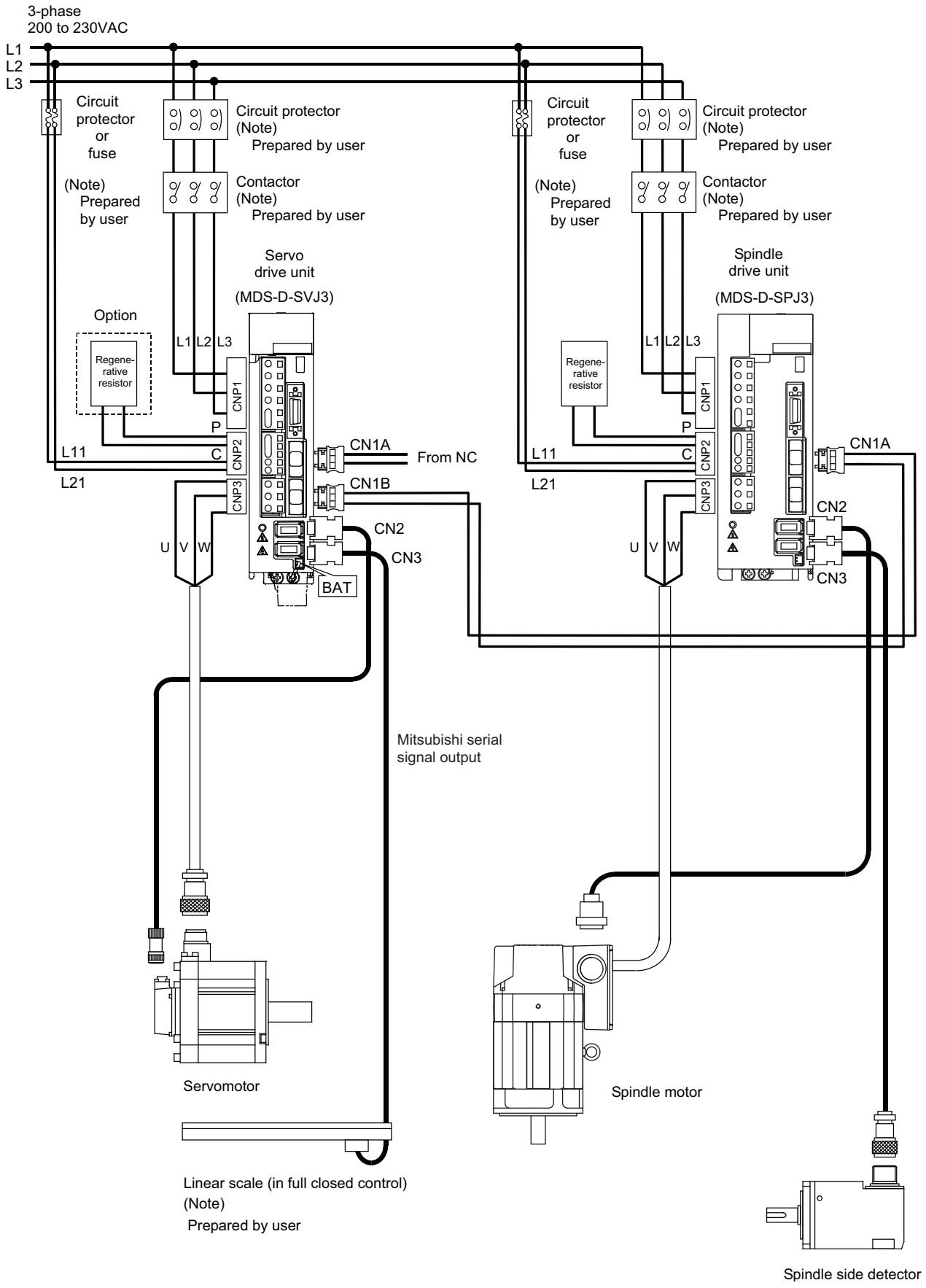
1 Introduction

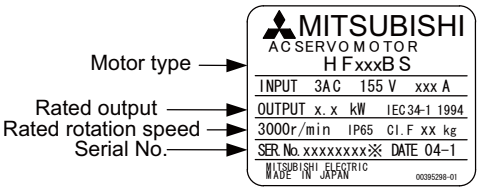
1-1 Servo/spindle drive system configuration

1-1-1 System configuration



1-2 Explanation of type

1-2-1 Servomotor type



Motor rating nameplate

< HF Series >

HF (1) (2) (3) (4) - (5)

(1) Rated output · Maximum rotation speed

Symbol	Rated output	Maximum rotation speed	Flange size (mm)
75	0.75 kW	5000 r/min	90 SQ.
105	1.0 kW	5000 r/min	90 SQ.
54	0.5 kW	4000 r/min	130 SQ.
104	1.0 kW	4000 r/min	130 SQ.
154	1.5 kW	4000 r/min	130 SQ.
224	2.2 kW	4000 r/min	130 SQ.
204	2.0 kW	4000 r/min	176 SQ.
354	3.5 kW	3500 r/min	176 SQ.
123	1.2 kW	3000 r/min	130 SQ.
223	2.2 kW	3000 r/min	130 SQ.
303	3.0 kW	3000 r/min	176 SQ.
142	1.4 kW	2000 r/min	130 SQ.
302	3.0 kW	2000 r/min	176 SQ.

(2) Magnetic brakes

Symbol	Magnetic brake
None	None
B	With magnetic brakes

(3) Shaft end structure

Symbol	Shaft end structure
S	Straight
T	Taper

(Note) "Taper" is available for the motor whose flange size is 90 SQ. mm or 130 SQ. mm.

(4) Production plant

Symbol	Production plant
None	Mitsubishi Electric Corporation Nagoya Works
C	Mitsubishi Electric Dalian Industrial Products Co., Ltd. (MDI)

(5) Detector

Symbol	Detection method	Resolution
A48	Absolute position	260,000 p/rev
A51		1,000,000 p/rev

< HF-KP Series >

HF-KP 13 (1) J-S17

Rated output · Maximum rotation speed

Symbol	Rated output	Maximum rotation speed	Flange size (mm)
13	0.1 kW	6000 r/min	40 SQ.

(1) Magnetic brake

Symbol	Magnetic brake
None	None
B	With magnetic brakes

(Note) The motor-end detector has absolute position specifications,but is not equipped with the capacitor for data backup.
Thus, absolute position is lost immediately after disconnection of the detector cable.

HF-KP (1) (2) JW04-S6

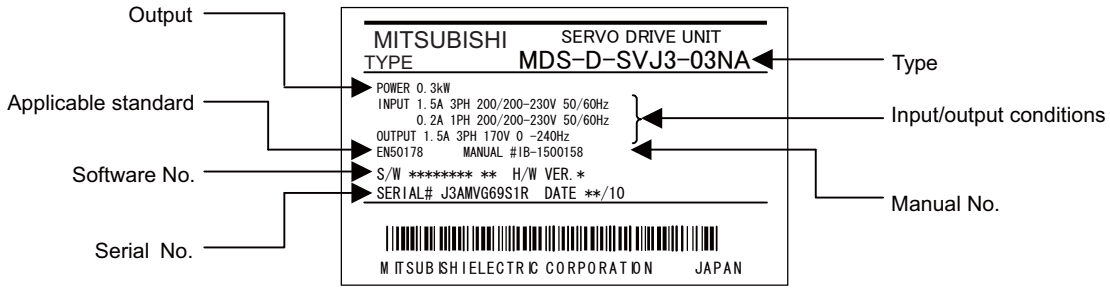
(1) Rated output · Maximum rotation speed

Symbol	Rated output	Maximum rotation speed	Flange size (mm)
23	0.2 kW	6000 r/min	60 SQ.
43	0.4 kW	6000 r/min	60 SQ.
73	0.75 kW	6000 r/min	80 SQ.

(2) Magnetic brake

Symbol	Magnetic brake
None	None
B	With magnetic brake

1-2-2 Servo drive unit type



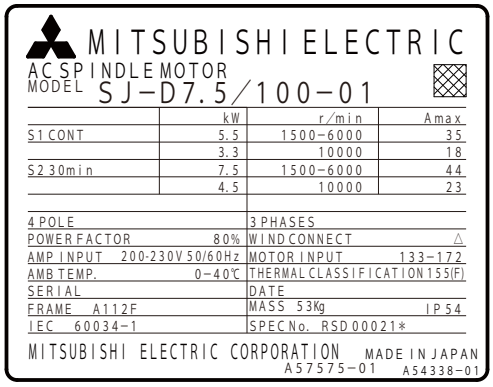
Rating nameplate

MDS-D-SVJ3- ①

(1) Unit Type MDS-D-SVJ3-	Unit width	Compatible motor type: Stall torque (N·m) / Rated output	HF□ 75	105	54	104	154	224	204	354	123	223	303	142	302	HF-KP□ 13	23	43	73
			2.0	3.0	2.9	5.9	9.0	12.0	13.7	22.5	7.0	12.0	22.5	11.0	20.0	0.32	0.64	1.3	2.4
03NA	40mm	0.3kW														●	●		
04NA	40mm	0.4kW																●	
07NA	60mm	0.75kW	●	●	●														●
10NA	90mm	1.0kW				●					●	●		●	●				
20NA	90mm	2.0kW					●	●	●				●						
35NA	90mm	3.5kW								●									

● Indicates the compatible motor for each servo drive unit.

1-2-3 Spindle motor type


MITSUBISHI ELECTRIC
AC SPINDLE MOTOR
MODEL SJ-D7.5/100-01

	kW	r/min	Amax
S1 CONT	5.5	1500-6000	35
	3.3	10000	18
S2 30min	7.5	1500-6000	44
	4.5	10000	23

4 POLE	3 PHASES
POWER FACTOR 80%	WIND CONNECT △
AMP INPUT 200-230V 50/60Hz	MOTOR INPUT 133-172
AMB TEMP. 0-40℃	THERMAL CLASSIFICATION 155(F)
SERIAL	DATE
FRAME A112F	MASS 53Kg IP54
IEC 60034-1	SPEC No. RSD00021*

MITSUBISHI ELECTRIC CORPORATION MADE IN JAPAN
A57575-01 A54338-01

Rating nameplate

< SJ-D Series >

SJ-D (1) (2) / (3) – (4) (5) – (6)

(1) Motor series

Symbol	Motor Series
None	Standard
J	Compact & lightweight specifications

(2) Short time (or %ED) rated output

Symbol	Short-time rated output
3.7	3.7kW
5.5	5.5kW
7.5	7.5kW
11	11kW

(3) Maximum rotation speed
Indicates the hundreds place and higher order digits.

(4) Specification code
Indicates a specification code (01 to 99).

(5) Detector

Symbol	Type
None	Type 1
T	Type 2

(6) Option (Note)

Symbol	Option
None	Standard (flange type, without oil seal, without key, coil changeover unavailable, air-cooling, solid shaft)
C	With key
J	Oil seal
X	Reversed cooling air

(Note) If more than one option is included, the symbols are in alphabetical order.

(Note) This explains the model name system of a spindle motor, and all combinations of motor types listed above do not exist.

< Standard spindle motor series >

SJ- (1) (2) (3) (4) – (5) (6) T

(1) Motor series

Symbol	Motor series
V	Medium-inertia series
VL	Low-inertia series

(2) Coil changeover

Symbol	Coil changeover
None	Unavailable

(3) Shaft configuration

Symbol	Axis configuration
None	Standard
S	Hollow shaft

(4) Short time rated output

Symbol	Short time rated output
0.75	0.75 kW
1.5	1.5 kW
2.2	2.2 kW
3.7	3.7 kW
5.5	5.5 kW
7.5	7.5 kW
11	11 kW

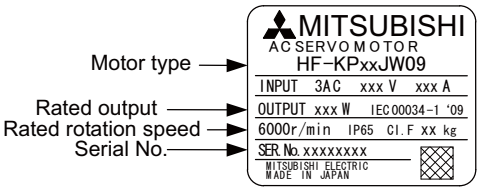
(3) Specification code
The SJ-V/VL Series is indicated with a specification code (01 to 99).

(6) Special specification

Symbol	Special specification
None	Standard
Z	High-speed bearing
FZ	High-speed bearing front-lock

(Note) This explains the model name system of a spindle motor, and all combinations of motor types listed above do not exist.

1-2-4 Tool spindle motor type



Motor rating nameplate

Rating nameplate

< HF-KP Series >

HF-KP (1) J (2) W09

(1) Rated output and maximum rotation speed

Symbol	Rated output	Maximum rotation speed	Flange size (mm)
46	0.4 kW	6000 r/min	60 SQ.
56	0.5 kW	6000 r/min	60 SQ.
96	0.9 kW	6000 r/min	80 SQ.

(2) Option

Symbol	Option
None	Without keyway
K	With keyway (with key)

< HF Series >

HF (1) (2) - (3)

(1) Rated output · Maximum rotation speed

Symbol	Rated output	Maximum	Flange size (mm)
75	0.75 kW	4000 r/min	90 SQ.
105	1.0 kW	4000 r/min	90 SQ.
54	0.5 kW	3000 r/min	130 SQ.
104	1.0 kW	3000 r/min	130 SQ.
154	1.5 kW	3000 r/min	130 SQ.
224	2.2 kW	3000 r/min	130 SQ.
204	2.0 kW	3000 r/min	176 SQ.
123	1.2 kW	2000 r/min	130 SQ.
223	2.2 kW	2000 r/min	130 SQ.
303	3.0 kW	2000 r/min	176 SQ.

(2) Shaft end structure

Symbol	Shaft end structure
S	Straight

(3) Detector

Symbol	Detection method	Resolution
A48	Absolute	262,144 p/rev

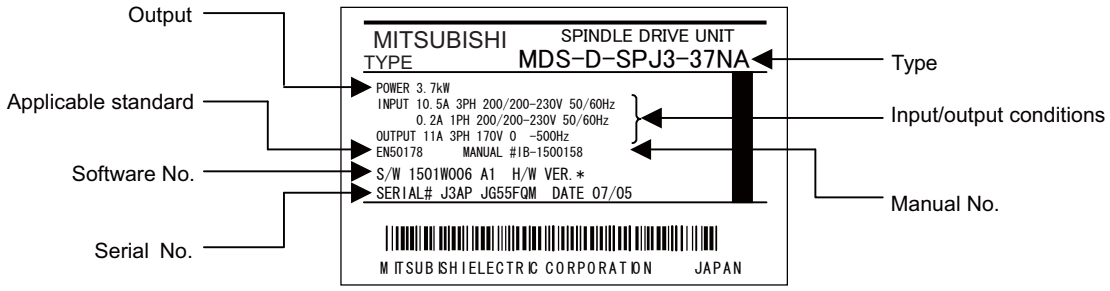
(Note) Detector A51 can not be used with the tool spindle motor.

< Combination with spindle drive unit >

Unit Type MDS-D-SPJ3-		Compatible motor type	HF□										HF-KP□		
			75	105	54	104	154	224	204	123	223	303	46	56	96
	Unit width	Stall torque (N·m) / Rated output	1.8	2.4	1.6	3.2	4.8	7.0	6.4	5.7	10.5	14.3	0.64	0.8	1.4
075NA	60mm	0.75kW	●	●	●					●			●	●	●
22NA	90mm	2.2kW				●					●				
37NA		3.7kW					●	●	●			●			
55NA	130mm	5.5kW													
75NA		7.5kW													
110NA	172mm	11.0kW													

● Indicates the compatible motor for each spindle drive unit.

1-2-5 Spindle drive unit type



Rating nameplate

MDS-D-SPJ3- **(1)**

(1) Capacity

Symbol	Rated output	Unit width
075NA	0.75kW	60mm wide
22NA	2.2kW	90mm wide
37NA	3.7kW	
55NA	5.5kW	130mm wide
75NA	7.5kW	
110NA	11.0kW	172mm wide

2

Specifications

Contents

2 Specifications

2-1 Servomotor

2-1-1 Specifications list

< HF Series >

Servomotor type		HF Series							
		ABS specifications: HF □ -A51 / -A48							
		HF75	HF105	HF54	HF104	HF154	HF224	HF204	HF354
Compatible servo drive unit type	MDS-D-SVJ3-	07NA	07NA	07NA	10NA	20NA	20NA	20NA	35NA
Continuous characteris-tics	Rated output [kW]	0.75	1.0	0.5	1.0	1.5	2.2	2.0	3.5
	Rated current [A]	2.8	3.6	1.8	3.6	5.8	8.5	6.8	13.8
	Rated torque [N•m]	1.8	2.4	1.6	3.2	4.8	7.0	6.4	11.1
	Stall current [A]	3.2	4.6	3.2	6.6	11.0	14.5	14.6	22.0
	Stall torque [N•m]	2.0	3.0	2.9	5.9	9.0	12.0	13.7	22.5
Power facility capacity [kVA]		1.5	2.0	1.1	2.0	2.8	4.1	3.7	6.4
Rated rotation speed [r/min]		4000		3000					
Maximum rotation speed [r/min]		5000		4000					3500
Maximum current [A]		14.0	15.5	16.8	29.0	52.0	57.0	52.0	64.0
Maximum torque [N•m]		8.0	11.0	13.0	23.3	42.0	46.5	42.0	65.0
Power rate at continuous rated torque [kW/s]		12.3	11.2	4.1	8.4	12.7	20.7	10.6	16.5
Motor inertia [kg•cm^2]		2.6	5.1	6.1	11.9	17.8	23.7	38.3	75.0
Motor inertia with brake [kg•cm^2]		2.8	5.3	8.3	14.1	20.0	25.9	48.0	84.7
Maximum motor shaft conversion load inertia ratio		High-speed, high-accuracy machine: 3 times or less of motor inertia General machine tool (interpolation axis): 5 times or less of motor inertia General machine (non-interpolation axis): 7 times or less of motor inertia							
Motor side detector		Resolution per motor revolution A51: 1,000,000 pulse/rev, A48: 260,000 pulse/rev							
Degree of protection		IP67 (The shaft-through portion is excluded.))							
Environment	Ambient temperature	Operation: 0 to 40 ℃ (with no freezing), Storage: -15 ℃ to 70 ℃ (with no freezing)							
	Ambient humidity	Operation: 80%RH or less (with no dew condensation), Storage: 90%RH or less (with no dew condensation)							
	Atmosphere	Indoors (no direct sunlight); no corrosive gas, inflammable gas, oil mist, or dust							
	Altitude	Operation: 1000 meters or less above sea level, Storage: 10000 meters or less above sea level							
	Vibration	X,Y:24.5m/s^2 (2.5G)						X:24.5m/s^2 (2.5G) Y:29.4m/s^2 (3G)	
Flange size [mm]		90 SQ.	90 SQ.	130 SQ.	130 SQ.	130 SQ.	130 SQ.	176 SQ.	176 SQ.
Total length (excluding shaft) [mm] (Note 3)		126.5	162.5	118.5	140.5	162.5	184.5	143.5	183.5
Flange fitting diameter [mm]		φ80	φ80	φ110	φ110	φ110	φ110	φ114.3	φ114.3
Shaft diameter [mm]		φ14	φ14	φ24	φ24	φ24	φ24	φ35	φ35
Mass Without / with brake [kg]		2.5/3.9	4.3/5.7	4.8/6.8	6.5/8.5	8.3/10.3	10.0/12.0	12.0/18.0	19.0/25.0
Heat-resistant class		Class F (155°C)							

(Note 1) The above characteristics values are representative values. The maximum current and maximum torque are the values when combined with the drive unit.

(Note 2) The total length will be 3.5mm longer when using an A51 detector.

For outline dimension drawings, refer to "DRIVE SYSTEM DATA BOOK" (IB-1500273(ENG)).

< HF Series >

Servomotor type		HF Series				
		ABS specifications: HF ☐ -A51 / -A48				
		HF123	HF223	HF303	HF142	HF302
Compatible servo drive unit type	MDS-D-SVJ3-	10NA	10NA	20NA	10NA	10NA
Continuous characteris-tics	Rated output [kW]	1.2	2.2	3.0	1.4	3.0
	Rated current [A]	5.2	9.0	10.7	3.9	7.8
	Rated torque [N•m]	5.7	10.5	14.3	6.7	14.3
	Stall current [A]	6.4	10.2	15.8	6.4	10.9
	Stall torque [N•m]	7.0	12.0	22.5	11.0	20.0
Power facility capacity [kVA]		2.3	4.1	5.5	2.7	5.5
Rated rotation speed [r/min]		2000			2000	
Maximum rotation speed [r/min]		3000			2000	
Maximum current [A]		15.5	29.0	48.0	15.5	29.0
Maximum torque [N•m]		17.0	32.0	64.0	26.5	50.0
Power rate at continuous rated torque [kW/s]		27.3	46.5	27.3	25.2	27.3
Motor inertia [kg•cm^2]		11.9	23.7	75.0	17.8	75.0
Motor inertia with brake [kg•cm^2]		14.1	25.9	84.7	20.0	84.7
Maximum motor shaft conversion load inertia ratio		High-speed, high-accuracy machine: 3 times or less of motor inertia General machine tool (interpolation axis): 5 times or less of motor inertia General machine (non-interpolation axis): 7 times or less of motor inertia				
Motor side detector		Resolution per motor revolution A51: 1,000,000 pulse/rev, A48: 260,000 pulse/rev				
Degree of protection		P67 (The shaft-through portion is excluded.)				
Environment	Ambient temperature	Operation: 0 to 40 ℃ (with no freezing), Storage: -15 ℃ to 70 ℃ (with no freezing)				
	Ambient humidity	Operation: 80%RH or less (with no dew condensation), Storage: 90%RH or less (with no dew condensation)				
	Atmosphere	Indoors (no direct sunlight); no corrosive gas, inflammable gas, oil mist, or dust				
	Altitude	Operation: 1000 meters or less above sea level, Storage: 10000 meters or less above sea level				
	Vibration	X,Y:24.5m/s^2 (2.5G)		X:24.5m/s^2 (2.5G) Y:29.4m/s^2 (3G)	X,Y:24.5m/s^2 (2.5G)	X:24.5m/s^2 (2.5G) Y:29.4m/s^2 (3G)
Flange size [mm]		130 SQ.	130 SQ.	176 SQ.	130 SQ.	176 SQ.
Total length (excluding shaft) [mm] (Note 3)		140.5	184.5	183.5	162.5	183.5
Flange fitting diameter [mm]		φ110	φ110	φ114.3	φ110	φ114.3
Shaft diameter [mm]		φ24	φ24	φ35	φ24	φ35
Mass Without / with brake [kg]		6.5/8.5	10.0/12.0	19.0/25.0	8.3/10.3	19.0/25.0
Heat-resistant class		Class F (155°C)				

(Note 1) The above characteristics values are representative values. The maximum current and maximum torque are the values when combined with the drive unit.

(Note 2) The total length will be 3.5mm longer when using an A51detector.

For outline dimension drawings, refer to "DRIVE SYSTEM DATA BOOK" (IB-1500273(ENG)).

2 Specifications

< HF-KP Series >

Servomotor type		HF-KP Series			
		Absolute position standard			
		HF-KP13J-S17	HF-KP23JW04-S6	HF-KP43JW04-S6	HF-KP73JW04-S6
Compatible servo drive unit type	MDS-D-SVJ3-	03NA	03NA	04NA	07NA
Continuous characteristics	Rated output [kW]	0.1	0.2	0.4	0.75
	Rated current [A]	0.77	1.4	2.7	5.2
	Rated torque [N•m]	0.32	0.64	1.3	2.4
	Stall current [A]	0.77	1.4	2.7	5.2
	Stall torque [N•m]	0.32	0.64	1.3	2.4
Power facility capacity [kVA]		0.4	0.6	0.9	1.5
Rated rotation speed [r/min]		3000			
Maximum rotation speed [r/min]		6000			
Maximum current [A]		2.31	4.3	8.5	15.5
Maximum torque [N•m]		0.95	1.9	3.8	7.2
Power rate at continuous rated torque [kW/s]		11.5	16.9	38.6	39.9
Motor inertia [kg•cm^2]		0.088	0.23	0.42	1.43
Motor inertia with brake [kg•cm^2]		0.090	0.31	0.50	1.63
Maximum motor shaft conversion load inertia ratio		General machine (non-interpolation axis): 15 times or less of motor inertia			
Motor side detector		Resolution per motor revolution: 260,000 pulse/rev (Note2)			
Degree of protection		IP65 (The shaft-through portion is excluded.)			
Environment	Ambient temperature	Operation: 0 to 40 ℃ (with no freezing), Storage: -15 ℃ to 70 ℃ (with no freezing)			
	Ambient humidity	Operation: 80%RH or less (with no dew condensation), Storage: 90%RH or less (with no dew condensation)			
	Atmosphere	Indoors (no direct sunlight); no corrosive gas, inflammable gas, oil mist, or dust			
	Altitude	Operation: 1000 meters or less above sea level, Storage: 10000 meters or less above sea level			
	Vibration	X,Y: 49m/s^2 (5G)			
Flange size [mm]		40 SQ. (Note4)	60 SQ.	60 SQ.	80 SQ.
Total length (excluding shaft) [mm]		92.8	98	119.9	134.2
Flange fitting diameter [mm]		φ30	φ50	φ50	φ70
Shaft diameter [mm]		φ8	φ14	φ14	φ19
Mass Without / with brake [kg]		0.66/0.96	1.2/1.8	1.7/2.3	2.9/4.1
Heat-resistant class		Class B (130°C)			

(Note 1) The above characteristics values are representative values. The maximum current and maximum torque are the values when combined with the drive unit.

(Note 2) HF-KP13J-S17 is an absolute position specification motor, however this motor is not equipped with a capacitor for data backup.Thus the absolute position is lost as soon as the detector cable is disconnected.

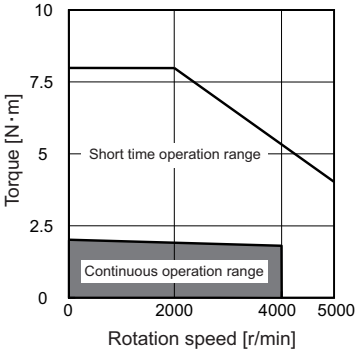
(Note 3) The outside dimensions of the detector part are 50 sq. mm.

For outline dimension drawings, refer to "DRIVE SYSTEM DATA BOOK" (IB-1500273(ENG)).

2-1-2 Torque characteristics

< HF Series >

[HF75]



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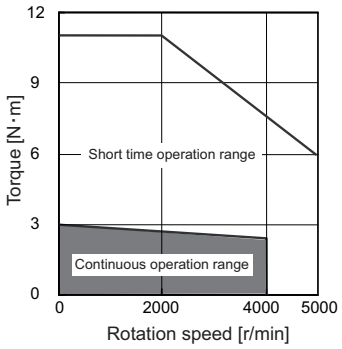

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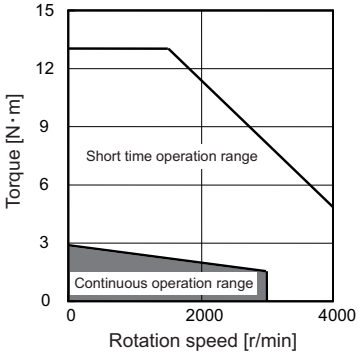

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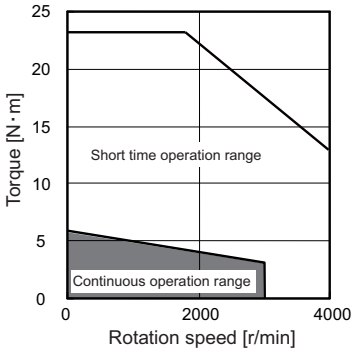

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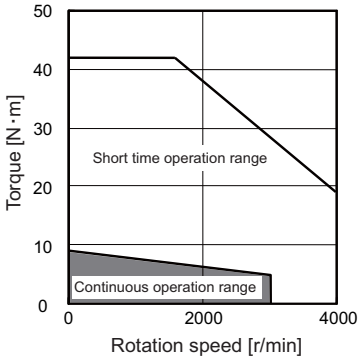

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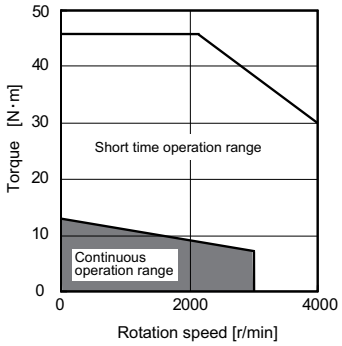

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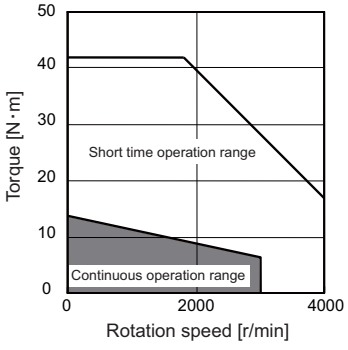

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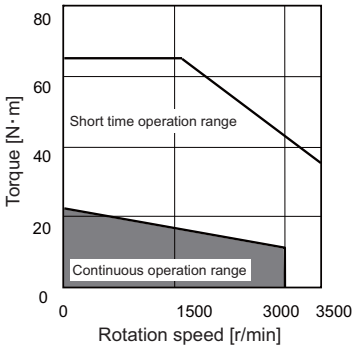

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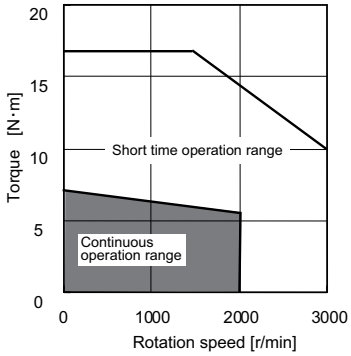

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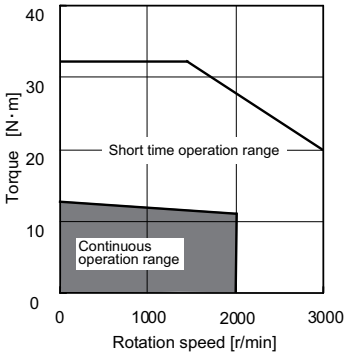

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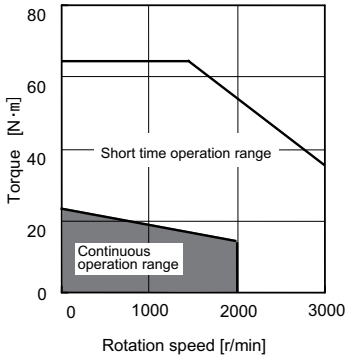
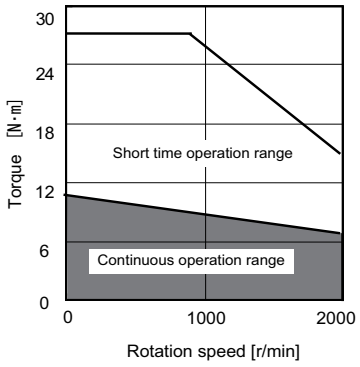


(Note) The above graphs show the data when applied the input voltage of 200VAC. When the input voltage is 200VAC or less, the short time operation range is limited.

2 Specifications

< HF Series >

[HF142]



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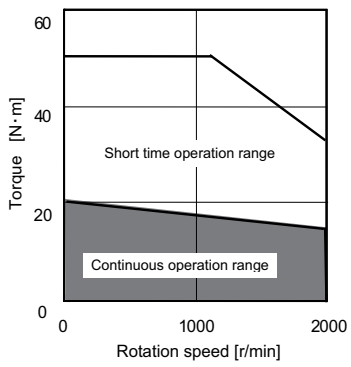
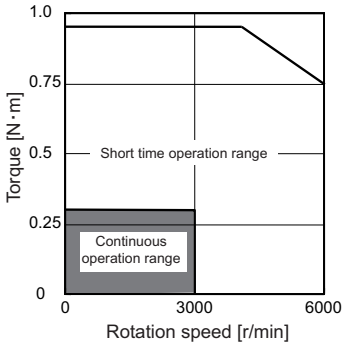


< HF-KP Series >

[HF-KP13J-S17]



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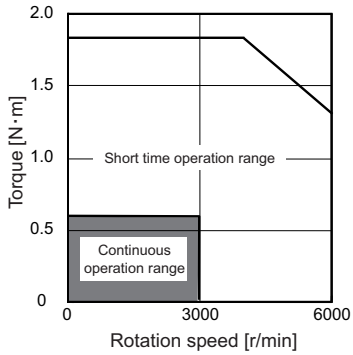

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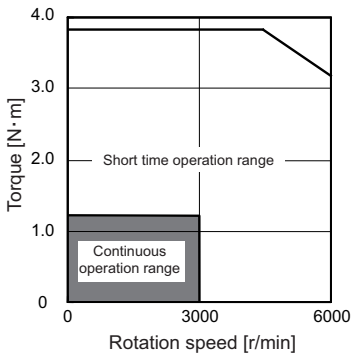

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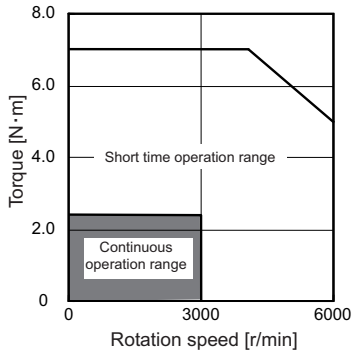


(Note) The above graphs show the data when applied the input voltage of 200VAC. When the input voltage is 200VAC or less, the short time operation range is limited.

2-2 Spindle motor

2-2-1 Specifications

< SJ-D Series (Standard) >

Spindle motor type		SJ-D3.7/100-01	SJ-D5.5/100-01	SJ-D7.5/100-01	SJ-D11/80-01
Compatible spindle drive unit type	MDS-D-SPJ3-	37NA	55NA	75NA	110NA
Output capacity	Continuous rating [kW]	2.2	3.7	5.5	7.5
	Short time rating [kW]	3.7 (15-minute rating)	5.5 (30-minute rating)	7.5 (30-minute rating)	11 (30-minute rating)
Power facility capacity [kVA]		6.7	9.9	13.4	19.6
Base rotation speed [r/min]		1500	1500	1500	1500
Maximum rotation speed [r/min]		10000	10000	10000	8000
Frame No.		B90	D90	A112	B112
Continuous rated torque [N•m]		14.0	23.6	35.0	47.7
GD^2 [kg•m^2]		0.030	0.053	0.094	0.122
Inertia [kg•m^2]		0.0074	0.013	0.023	0.031
Tolerable radial load [N]		980	1470	1960	1960
Cooling fan	Input voltage	3-phase 200V			
	Maximum power consumption	38W	38W	50W	50W
Environment	Ambient temperature	Operation: 0 to 40 ℃ (with no freezing), Storage: -20 ℃ to 65 ℃ (with no freezing)			
	Ambient humidity	Operation: 90%RH or less (with no dew condensation), Storage: 90%RH or less (with no dew condensation)			
	Atmosphere	Indoors (no direct sunlight); no corrosive gas, inflammable gas, oil mist, or dust			
	Altitude	Operation: 1000 meters or less above sea level, Storage: 1000 meters or less above sea level, Transportation: 10000 meters or less above sea level			
Degree of protection		IP54 (The shaft-through portion is excluded.)			
Flange size [mm]		174 SQ.	174 SQ.	204 SQ.	204 SQ.
Total length (excluding shaft) [mm]		327	417	439	489
Flange fitting diameter [mm]		φ150	φ150	φ180	φ180
Shaft diameter [mm]		φ28	φ28	φ32	φ48
Mass [kg]		26	39	53	64
Heat-resistant class		Class F (155°C)			

(Note) The tolerable radial load is the value calculated at the center of output shaft.

For outline dimension drawings, refer to "DRIVE SYSTEM DATA BOOK" (IB-1500273(ENG)).

2 Specifications

< SJ-DJ Series (Compact & lightweight specifications) >

Spindle motor type		SJ-DJ5.5/100-01	SJ-DJ7.5/100-01	SJ-DJ11/100-01
Compatible spindle drive unit type	MDS-D-SPJ3-	55NA	75NA	110NA
Output capacity	Continuous rating [kW]	3.7	5.5	7.5
	Short time rating [kW]	5.5 (25%ED rating)	7.5 (15-minute rating)	11 (15-minute rating)
Power facility capacity [kVA]		9.9	13.4	19.6
Base rotation speed [r/min]		1500	1500	1500
Maximum rotation speed [r/min]		10000	10000	10000
Frame No.		B90	D90	A112
Continuous rated torque [N•m]		17.7	26.3	35.8
GD^2 [kg•m^2]		0.030	0.053	0.094
Inertia [kg•m^2]		0.0074	0.013	0.023
Tolerable radial load [N]		980	1470	1960
Cooling fan	Input voltage	3-phase 200V		
	Maximum power consumption	38W	38W	50W
Environment	Ambient temperature	Operation: 0 to 40 ℃ (with no freezing), Storage: -20 ℃ to 65 ℃ (with no freezing)		
	Ambient humidity	Operation: 90%RH or less (with no dew condensation), Storage: 90%RH or less (with no dew condensation)		
	Atmosphere	Indoors (no direct sunlight); no corrosive gas, inflammable gas, oil mist, or dust		
	Altitude	Operation: 1000 meters or less above sea level, Storage: 1000 meters or less above sea level, Transportation: 10000 meters or less above sea level		
Degree of protection		IP54 (The shaft-through portion is excluded.)		
Flange size [mm]		174 SQ.	174 SQ.	204 SQ.
Total length (excluding shaft) [mm]		327	417	439
Flange fitting diameter [mm]		φ150	φ150	φ180
Shaft diameter [mm]		φ28	φ28	φ32
Mass [kg]		26	39	53
Heat-resistant class		Class F (155°C)		

(Note) The tolerable radial load is the value calculated at the center of output shaft.

For outline dimension drawings, refer to "DRIVE SYSTEM DATA BOOK" (IB-1500273(ENG)).

< SJ-V Series (Standard) >

Spindle motor type		SJ-VL0.75-01T	SJ-VL1.5-01T	SJ-V2.2-01T	SJ-V3.7-01T	SJ-V5.5-01ZT
Compatible spindle drive unit type	MDS-D-SPJ3-	075NA	22NA	22NA	37NA	55NA
Output capacity	Continuous rating [kW]	0.4	0.75	1.5	2.2	3.7
	Short time rating [kW]	0.75 (10-minute rating)	1.5 (10-minute rating)	2.2 (15-minute rating)	3.7 (15-minute rating)	5.5 (30-minute rating)
Power facility capacity [kVA]		1.5	2.8	4.1	6.7	9.9
Base rotation speed [r/min]		1500	1500	1500	1500	1500
Maximum rotation speed [r/min]		10000	10000	10000	10000	12000
Frame No.		A71	B71	A90	B90	D90
Continuous rated torque [N•m]		2.55	4.77	9.5	14.0	23.6
GD^2 [kg•m^2]		0.0053	0.0096	0.027	0.035	0.059
Inertia [kg•m^2]		0.0013	0.0024	0.007	0.009	0.0148
Tolerable radial load [N]		490	490	980	980	980
Cooling fan	Input voltage	Single-phase 200V	Single-phase 200V	Single-phase 200V	Single-phase 200V	Single-phase 200V
	Maximum power consumption	14W	14W	36W	36W	36W
Environment	Ambient temperature	Operation: 0 to 40 ℃ (with no freezing), Storage: -20 ℃ to 65 ℃ (with no freezing)				
	Ambient humidity	Operation: 90%RH or less (with no dew condensation), Storage: 90%RH or less (with no dew condensation)				
	Atmosphere	Indoors (no direct sunlight); no corrosive gas, inflammable gas, oil mist, or dust				
	Altitude	Operation: 1000 meters or less above sea level, Storage: 1000 meters or less above sea level, Transportation: 10000 meters or less above sea level				
Degree of protection		IP44				
Flange size [mm]		130 SQ.	130 SQ.	174 SQ.	174 SQ.	174 SQ.
Total length (excluding shaft) [mm]		265	325	300	330	425
Flange fitting diameter [mm]		φ110	φ110	φ150	φ150	φ150
Shaft diameter [mm]		φ22	φ22	φ28	φ28	φ28
Mass [kg]		15	20	25	30	49
Heat-resistant class		Class F (155°C)				

(Note) The tolerable radial load is the value calculated at the center of output shaft.

For outline dimension drawings, refer to "DRIVE SYSTEM DATA BOOK" (IB-1500273(ENG)).

2 Specifications

< SJ-V Series (Standard) >

Spindle motor type		SJ-V7.5-01ZT	SJ-V7.5-03ZT	SJ-V11-01T	SJ-V11-01ZT
Compatible spindle drive unit type	MDS-D-SPJ3-	75NA	110NA	110NA	110NA
Output capacity	Continuous rating [kW]	5.5	5.5	7.5	7.5
	Short time rating [kW]	7.5 (30-minute rating)	7.5 (30-minute rating)	11 (15-minute rating)	11 (30-minute rating)
Power facility capacity [kVA]		13.4	13.4	19.6	19.6
Base rotation speed [r/min]		1500	1500	1500	1500
Maximum rotation speed [r/min]		12000	10000	6000	8000
Frame No.		A112	A112	B112	B112
Continuous rated torque [N•m]		35	35	47.7	47.7
GD^2 [kg•m^2]		0.098	0.098	0.12	0.12
Inertia [kg•m^2]		0.0245	0.0245	0.03	0.03
Tolerable radial load [N]		980	980	1960	1960
Cooling fan	Input voltage	3-phase 200V	3-phase200V	3-phase 200V	3-phase 200V
	Maximum power consumption	40W	40W	40W	40W
Environment	Ambient temperature	Operation: 0 to 40 ℃ (with no freezing), Storage: -20 ℃ to 65 ℃ (with no freezing)			
	Ambient humidity	Operation: 90%RH or less (with no dew condensation), Storage: 90%RH or less (with no dew condensation)			
	Atmosphere	Indoors (no direct sunlight); no corrosive gas, inflammable gas, oil mist, or dust			
	Altitude	Operation: 1000 meters or less above sea level, Storage: 1000 meters or less above sea level, Transportation: 10000 meters or less above sea level			
Degree of protection		IP44			
Flange size [mm]		204 SQ.	204 SQ.	204 SQ.	204 SQ.
Total length (excluding shaft) [mm]		440	440	490	490
Flange fitting diameter [mm]		φ180	φ180	φ180	φ180
Shaft diameter [mm]		φ32	φ32	φ48	φ48
Mass [kg]		60	60	70	70
Heat-resistant class		Class F (155°C)			

(Note) The tolerable radial load is the value calculated at the center of output shaft.

For outline dimension drawings, refer to "DRIVE SYSTEM DATA BOOK" (IB-1500273(ENG)).

< SJ-V Series (High-speed) >

Spindle motor type		SJ-VL2.2-02ZT
Compatible spindle drive unit type	MDS-D-SPJ3-	37NA
Output capacity	Continuous rating [kW]	1.5
	Short time rating [kW]	2.2 (15-minute rating)
Power facility capacity [kVA]		4.1
Base rotation speed [r/min]		3000
Maximum rotation speed [r/min]		12000
Frame No.		B71
Continuous rated torque [N•m]		4.77
GD^2 [kg•m^2]		0.0096
Inertia [kg•m^2]		0.0024
Tolerable radial load [N]		196
Cooling fan	Input voltage	Single-phase 200V
	Maximum power consumption	14W
Environment	Ambient temperature	Operation: 0 to 40℃ (with no freezing), Storage: -20℃ to 65℃ (with no freezing)
	Ambient humidity	Operation: 90%RH or less (with no dew condensation), Storage: 90%RH or less (with no dew condensation)
	Atmosphere	Indoors (no direct sunlight); no corrosive gas, inflammable gas, oil mist, or dust
	Altitude	Operation: 1000 meters or less above sea level, Storage: 1000 meters or less above sea level Transportation: 10000 meters or less above sea level
Degree of protection		IP44
Flange size [mm]		130 SQ.
Total length (excluding shaft) [mm]		325
Flange fitting diameter [mm]		φ110
Shaft diameter [mm]		φ22
Mass [kg]		20
Heat-resistant class		Class F (155°C)

(Note) The tolerable radial load is the value calculated at the center of output shaft.

For outline dimension drawings, refer to "DRIVE SYSTEM DATA BOOK" (IB-1500273(ENG)).

2 Specifications

< SJ-VL Series (Low-inertia) >

Spindle motor type		SJ-VL11-05FZT-S01	SJ-VL11-10FZT	SJ-VL11-07ZT	SJ-VL11-07ZT
Compatible spindle drive unit type	MDS-D-SPJ3-	110NA	110NA	110NA	110NA
Output capacity	Continuous rating [kW]	1.5	2.2	5.5	7.5
	Short time rating [kW]	3 (10-minute rating)	3.7 (15-minute rating)	7.5 (30-minute rating)	11 (15-minute rating)
Power facility capacity [kVA]		5.5	6.7	13.4	19.6
Base rotation speed [r/min]		5000	1700	1500	2200
Maximum rotation speed [r/min]		12000	12000	12000	12000
Frame No.		B71	D90	B112	B112
Continuous rated torque [N•m]		2.8	12.4	35	32.6
GD^2 [kg•m^2]		0.0096	0.021	0.072	0.072
Inertia [kg•m^2]		0.0024	0.00525	0.018	0.018
Tolerable radial load [N]		980	245	980	980
Cooling fan	Input voltage	Single-phase 200V	Single-phase 200V	3-phase 240V	3-phase 240V
	Maximum power consumption	14W	41W	40W	40W
Environment	Ambient temperature	Operation: 0 to 40 ℃ (with no freezing), Storage: -20 ℃ to 65 ℃ (with no freezing)			
	Ambient humidity	Operation: 90%RH or less (with no dew condensation), Storage: 90%RH or less (with no dew condensation)			
	Atmosphere	Indoors (no direct sunlight); no corrosive gas, inflammable gas, oil mist, or dust			
	Altitude	Operation: 1000 meters or less above sea level, Storage: 1000 meters or less above sea level Transportation: 10000 meters or less above sea level			
Degree of protection		IP44			
Flange size [mm]		130 SQ.	174 SQ.	204 SQ.	204 SQ.
Total length (excluding shaft) [mm]		335	441	490	490
Flange fitting diameter [mm]		φ110	φ150	φ180	φ180
Shaft diameter [mm]		φ22	φ28	φ32	φ32
Mass [kg]		20	40	70	70
Heat-resistant class		Class F (155°C)			

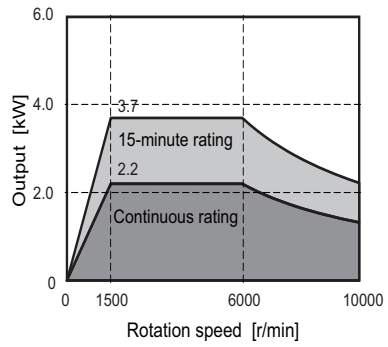
(Note) The tolerable radial load is the value calculated at the center of output shaft.

For outline dimension drawings, refer to "DRIVE SYSTEM DATA BOOK" (IB-1500273(ENG)).

2-2-2 Output characteristics

< SJ-D Series (Standard)>

[SJ-D3.7/100-01]



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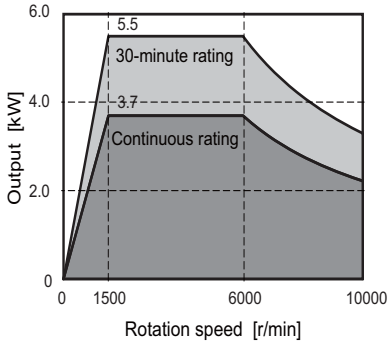

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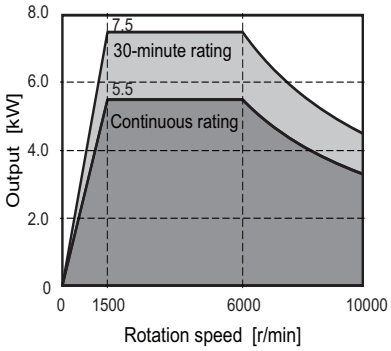

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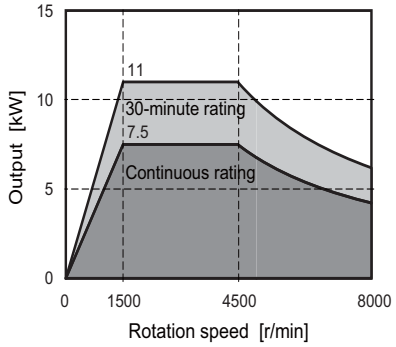

< SJ-DJ Series (Compact & lightweight specifications)>

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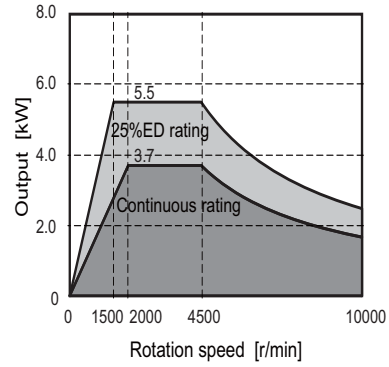

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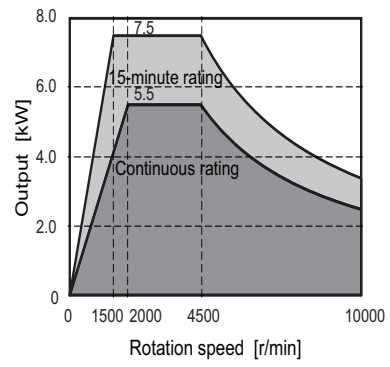

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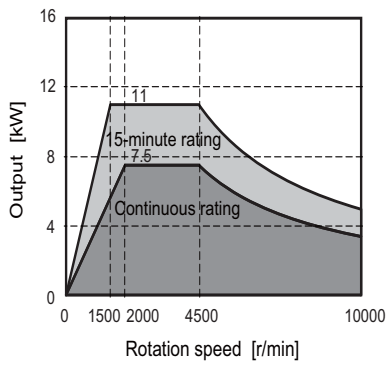

2 Specifications

< SJ-V Series (Standard)>

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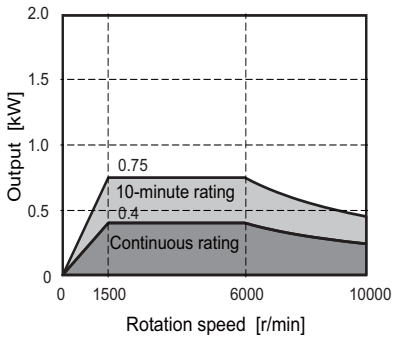

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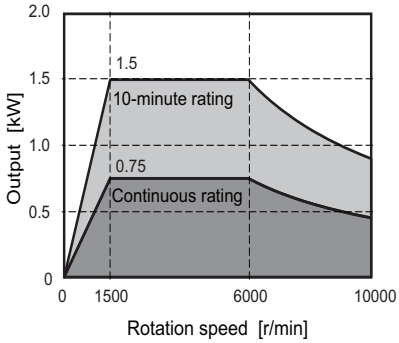

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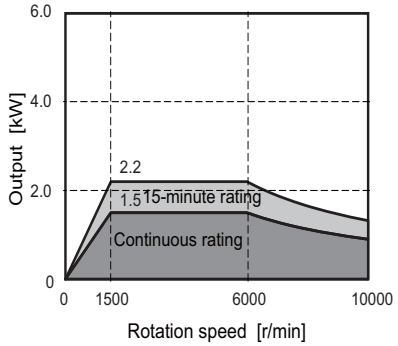

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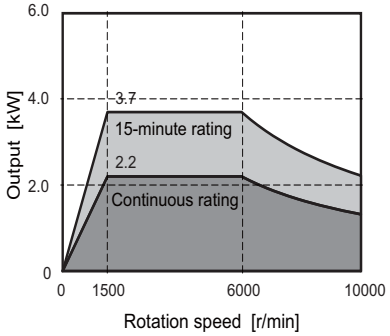

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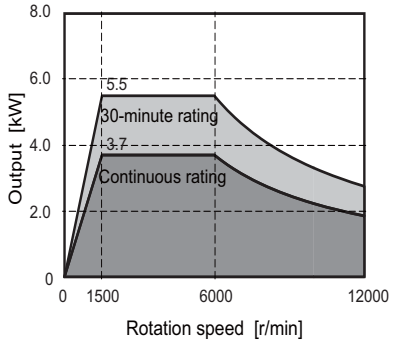

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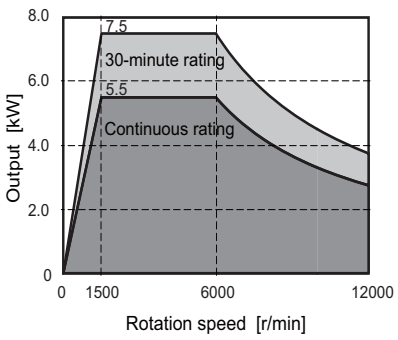

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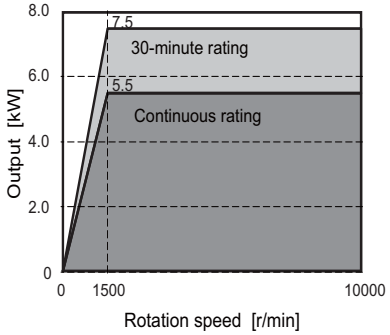

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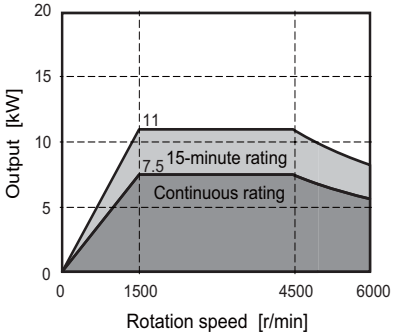

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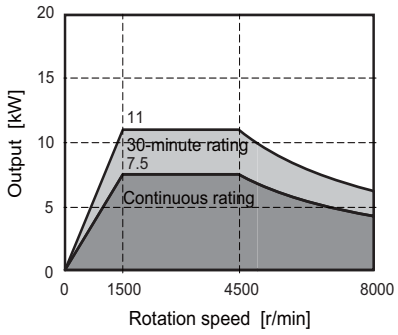
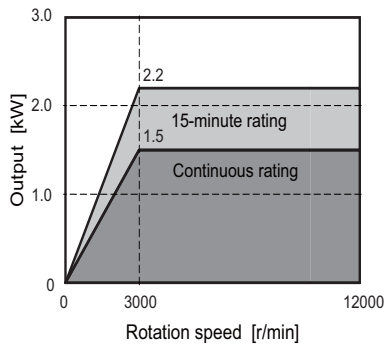


< SJ-V Series (High-speed)>

[SJ-VL2.2-02ZT]



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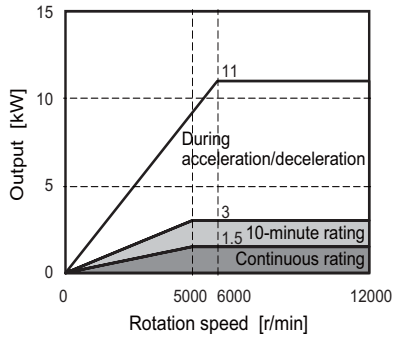

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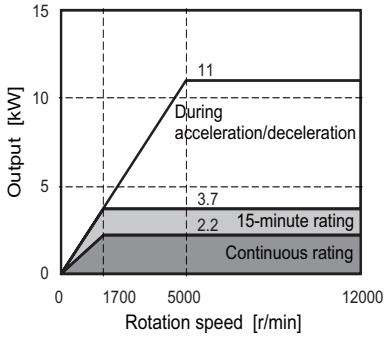

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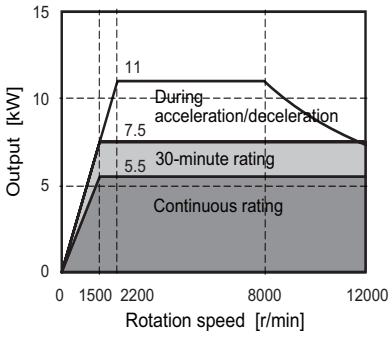

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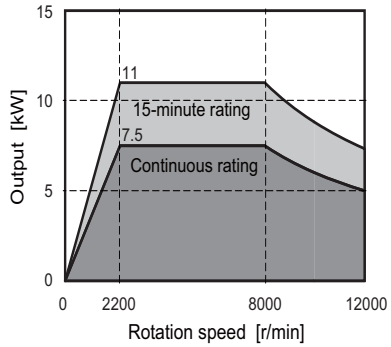


2-3 Tool spindle motor

2-3-1 Specifications

< HF-KP Series >

Tool spindle motor type		HF-KP Series		
		HF-KP □ -W09		
		HF-KP46	HF-KP56	HF-KP96
Compatible spindle drive unit type	MDS-D-SPJ3-	075NA	075NA	075NA
Continuous characteristics	Rated output [kW]	0.4	0.5	0.9
	Rated current [A]	1.5	1.8	3.6
	Rated torque [N•m]	0.64	0.80	1.43
Power facility capacity [kVA]		0.9	1.1	1.8
Rated rotation speed [r/min]		6000		
Maximum rotation speed [r/min]		6000		
Maximum current [A]		5.5	11.3	15.5
Maximum torque [N•m]		2.5	5.0	6.5
Motor inertia [kg•cm^2]		0.24	0.42	1.43
Motor side detector		Resolution per motor revolution W09:262,144 pulse/rev		
Degree of protection		IP67 (The shaft-through portion is excluded.)		
Environment	Ambient temperature	Operation: 0 to 40℃ (with no freezing), Storage: -15℃ to 70℃ (with no freezing)		
	Ambient humidity	Operation: 80%RH or less (with no dew condensation), Storage: 90%RH or less (with no dew condensation)		
	Atmosphere	Indoors (no direct sunlight); no corrosive gas, inflammable gas, oil mist, or dust		
	Altitude	Operation: 1000 meters or less above sea level, Storage: 10000 meters or less above sea level		
	Vibration	X,Y: 49m/s^2 (5G)		
Flange size [mm]		60 SQ.	60 SQ.	80 SQ.
Total length (excluding shaft) [mm]		118.7	140.6	149.1
Flange fitting diameter [mm]		φ50	φ50	φ70
Shaft diameter [mm]		φ14	φ14	φ19
Mass [kg]		1.2	1.7	2.9
Heat-resistant class		Class B (130°C)		

(Note) The above characteristics values are representative values. The maximum current and maximum torque are the values when combined with the drive unit.

For outline dimension drawings, refer to "DRIVE SYSTEM DATA BOOK" (IB-1500273(ENG)).

< HF Series >

Tool spindle motor type		HF Series									
		HF □ -A48									
		HF75	HF105	HF54	HF104	HF154	HF224	HF204	HF123	HF223	HF303
Compatible spindle drive unit type	MDS-D-SPJ3-	075NA	075NA	075NA	22NA	37NA	37NA	37NA	075NA	22NA	37NA
Continuous characteristics	Rated output [kW]	0.75	1.0	0.5	1.0	1.5	2.2	2.0	1.2	2.2	3.0
	Rated current [A]	2.8	3.6	1.8	3.6	5.8	8.5	6.8	5.2	9.0	10.7
	Rated torque [N•m]	1.8	2.4	1.6	3.2	4.8	7.0	6.4	5.7	10.5	14.3
Power facility capacity [kVA]		1.5	2.0	1.1	2.0	2.8	4.1	3.7	2.3	4.1	5.5
Rated rotation speed [r/min]		4000		3000					2000		
Maximum rotation speed [r/min]		4000		3000					2000		
Maximum current [A]		14.0	15.5	16.8	29.0	52.0	57.0	52.0	15.5	29.0	48.0
Maximum torque [N•m]		8.0	11.0	13.0	23.3	42.0	46.5	42.0	17.0	32.0	64.0
Motor inertia [kg•cm^2]		2.6	5.1	6.1	11.9	17.8	23.7	38.3	11.9	23.7	75.0
Motor side detector		Resolution per motor revolution A48 : 262,144 pulse/rev									
Degree of protection		IP67 (The shaft-through portion is excluded.)									
Environment	Ambient temperature	Operation: 0 to 40 ℃ (with no freezing), Storage: -15 ℃ to 70 ℃ (with no freezing)									
	Ambient humidity	Operation: 80%RH or less (with no dew condensation), Storage: 90%RH or less (with no dew condensation)									
	Atmosphere	Indoors (no direct sunlight); no corrosive gas, inflammable gas, oil mist, or dust									
	Altitude	Operation: 1000 meters or less above sea level, Storage: 10000 meters or less above sea level									
	Vibration	X:19.6m/s^2 (2G) Y:19.6m/s^2(2G)									
Flange size [mm]		90 SQ.	90 SQ.	130 SQ.	130 SQ.	130 SQ.	130 SQ.	176 SQ.	130 SQ.	130 SQ.	176 SQ.
Total length (excluding shaft) [mm]		126.5	162.5	118.5	140.5	162.5	184.5	143.5	140.5	184.5	183.5
Flange fitting diameter [mm]		φ80	φ80	φ110	φ110	φ110	φ110	φ114.3	φ110	φ110	φ114.3
Shaft diameter [mm]		φ14	φ14	φ24	φ24	φ24	φ24	φ35	φ24	φ24	φ35
Mass [kg]		2.5	4.3	4.8	6.5	8.3	10.0	12.0	6.5	10.0	19.0
Heat-resistant class		Class F (155°C)									

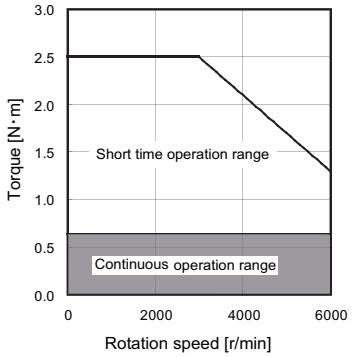
(Note) The above characteristics values are representative values. The maximum current and maximum torque are the values when combined with the drive unit.

For outline dimension drawings, refer to "DRIVE SYSTEM DATA BOOK" (IB-1500273(ENG)).

2-3-2 Output characteristics

< HF-KP Series >

[HF-KP46JW09]



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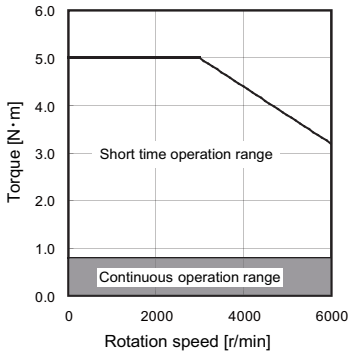
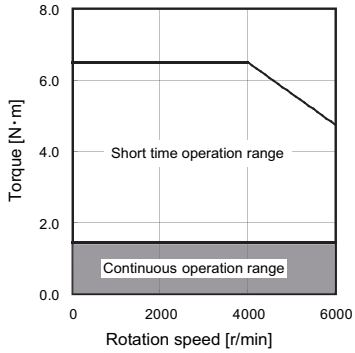


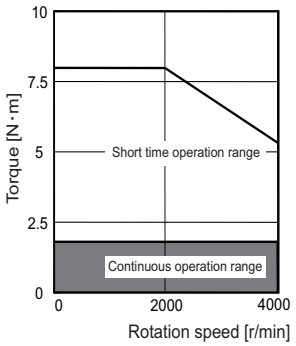
[HF-KP96JW09]



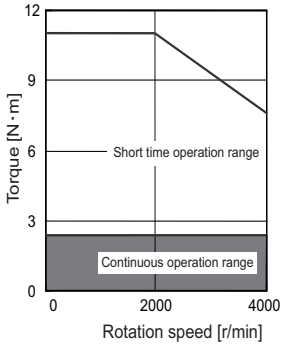
(Note) The above graphs show the data when applied the input voltage of 200VAC. When the input voltage is 200VAC or less, the short time operation range is limited.

< HF Series >

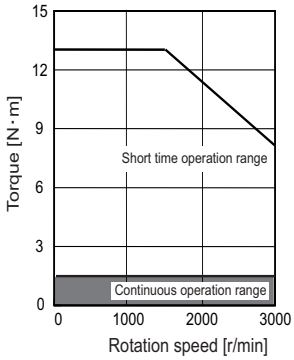
[HF75]



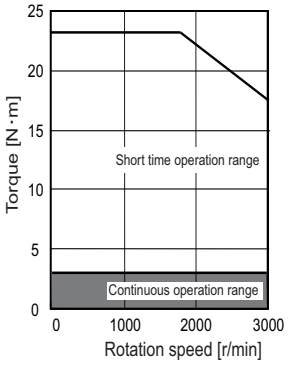
[HF105]



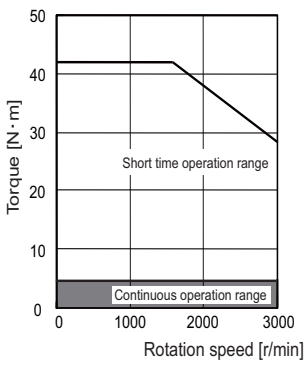
[HF54]



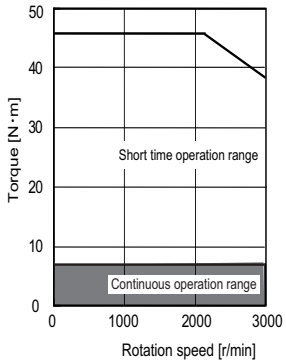
[HF104]



[HF154]



[HF224]



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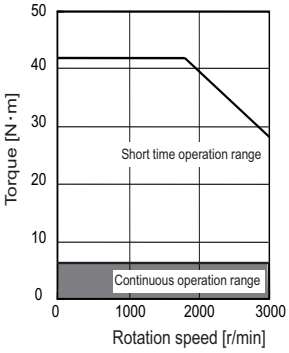
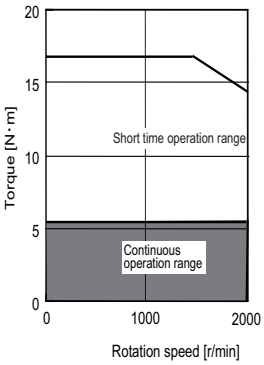
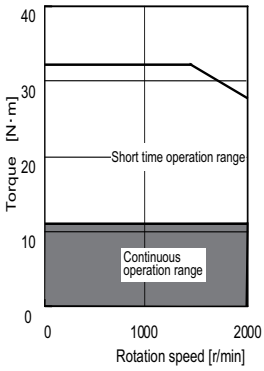


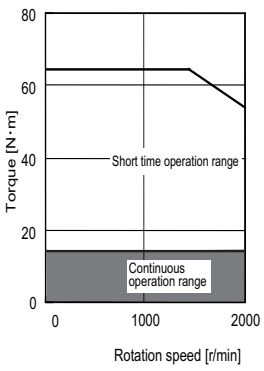
[HF123]



[HF223]



[HF303]



(Note) The above graphs show the data when applied the input voltage of 200VAC. When the input voltage is 200VAC or less, the short time operation range is limited.

2-4 Drive unit

2-4-1 Installation environment conditions

Common installation environment conditions for servo and spindle are shown below.

Environment	**Ambient temperature**	Operation: 0 to 55 ℃ (with no freezing), Storage / Transportation: -15 ℃ to 70 ℃ (with no freezing)
	Ambient humidity	Operation: 90%RH or less (with no dew condensation) Storage / Transportation: 90%RH or less (with no dew condensation)
	Atmosphere	Indoors (no direct sunlight) With no corrosive gas, inflammable gas, oil mist, dust or conductive fine particles
	Altitude	Operation/Storage: 1000 meters or less above sea level, Transportation: 13000 meters or less above sea level
	Vibration/impact	4.9m/s^2 (0.5G) / 49m/s^2 (5G)

2-4-2 Servo drive unit

		Servo drive unit MDS-D-SVJ3 Series					
Servo drive unit type MDS-D-SVJ3-		**03NA**	**04NA**	**07NA**	**10NA**	**20NA**	**35NA**
Rated output [kW]		0.3	0.4	0.7	1.0	2.0	3.5
Input	**Rated voltage [V]**	200AC (50Hz) / 200 to 230AC (60Hz) Tolerable fluctuation: between +10% and -15%					
	Frequency [Hz]	50/60 Tolerable fluctuation: between +5% and -5%					
	Rated current [A]	1.5	2.9	3.8	5.0	10.5	16.0
Output	**Rated voltage [V]**	AC155					
	Rated current [A]	1.5	3.2	5.8	6.0	11.0	17.0
Control power	**Voltage [V]**	200AC (50Hz) / 200 to 230AC (60Hz) Tolerable fluctuation: between +10% and -15%					
	Frequency [Hz]	50/60 Tolerable fluctuation: between +5% and -5%					
	Maximum current [A]	0.2					
	Maximum rush current [A]	30					
	Maximum rush conductivity time [ms]	6					
Earth leakage current [mA]		1 (Max. 2)					
Main circuit method		Converter with resistor regeneration circuit					
Control method		Sine wave PWM control method					
Braking		Regenerative braking and dynamic brakes					
	Dynamic brakes	Built-in					
External analog output		0 to +5V, 2ch (data for various adjustments)					
Degree of protection		Protection type (Protection method: IP20 [over all])					
Cooling method		Natural-cooling		Forced wind cooling			
Mass [kg]		0.8	1.0	1.4	2.3	2.3	2.3
Heat radiated at rated output [W]		25	35	50	90	130	195
Noise		Less than 55dB					
Unit outline dimension drawing		J1	J2	J3	J4a	J4a	J4b

For outline dimension drawings, refer to "DRIVE SYSTEM DATA BOOK" (IB-1500273(ENG)).

2-4-3 Spindle drive unit

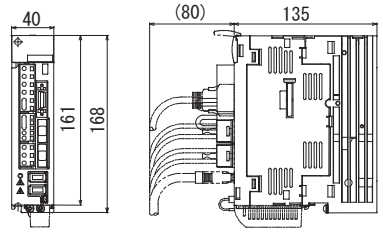
		Spindle drive unit MDS-D-SPJ3 Series					
Spindle drive unit type MDS-D-SPJ3-		**075NA**	**22NA**	**37NA**	**55NA**	**75NA**	**110NA**
Rated output [kW]		0.75	2.2	3.7	5.5	7.5	11.0
Input	**Rated voltage [V]**	200AC (50Hz) / 200 to 230AC (60Hz) Tolerable fluctuation: between +10% and -15%					
	Frequency [Hz]	50/60 Tolerable fluctuation: between +5% and -5%					
	Rated current [A]	2.6	9.0	10.5	16.0	16.0	35.4
Output	**Rated voltage [V]**	155AC					
	Rated current [A]	4.5	10.0	11.0	18.0	26.0	36.0
Control power	**Voltage [V]**	200AC (50Hz) / 200 to 230AC (60Hz) Tolerable fluctuation: between +10% and -15%					
	Frequency [Hz]	50/60 Tolerable fluctuation: between +5% and -5%					
	Maximum current [A]	0.2					
	Maximum rush current [A]	30					
	Maximum rush conductivity time [ms]	6					
Earth leakage current [mA]		6 (Max. 15)					
Main circuit method		Converter with resistor regeneration circuit					
Control method		Sine wave PWM control method					
Braking		Regenerative braking					
External analog output		0 to +5V, 2ch (data for various adjustments)					
Degree of protection		IP20			IP00		
Cooling method		Forced wind cooling					
Mass [kg]		1.4	2.1	2.1	4.6	4.6	6.5
Heat radiated at continuous rated output [W]		50	90	130	150	200	300
Noise		Less than 55dB					
Unit outline dimension drawing		J3	J4a	J4b	J5	J5	J6

For outline dimension drawings, refer to "DRIVE SYSTEM DATA BOOK" (IB-1500273(ENG)).

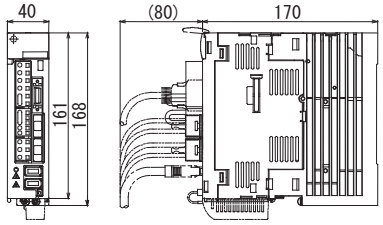
2-4-4 Unit outline dimension drawing

Unit [mm]

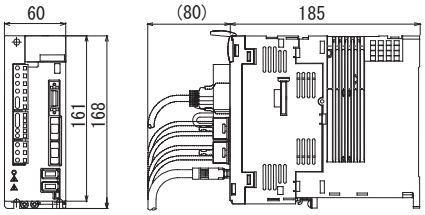
J 1



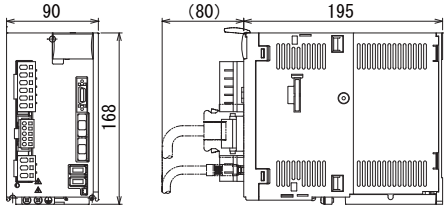
J 2



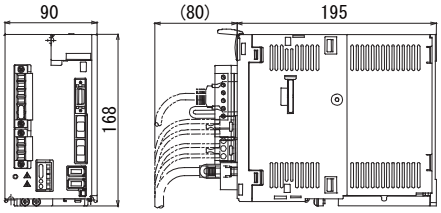
J 3



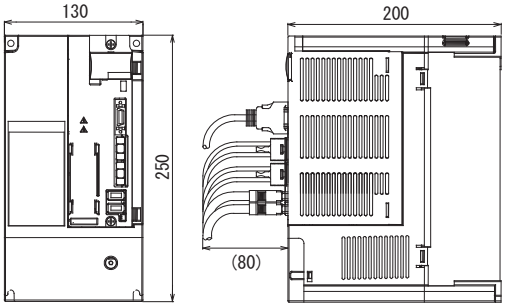
J 4a



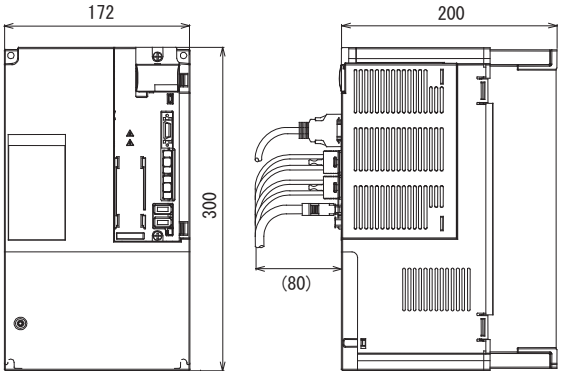
J 4b



J 5

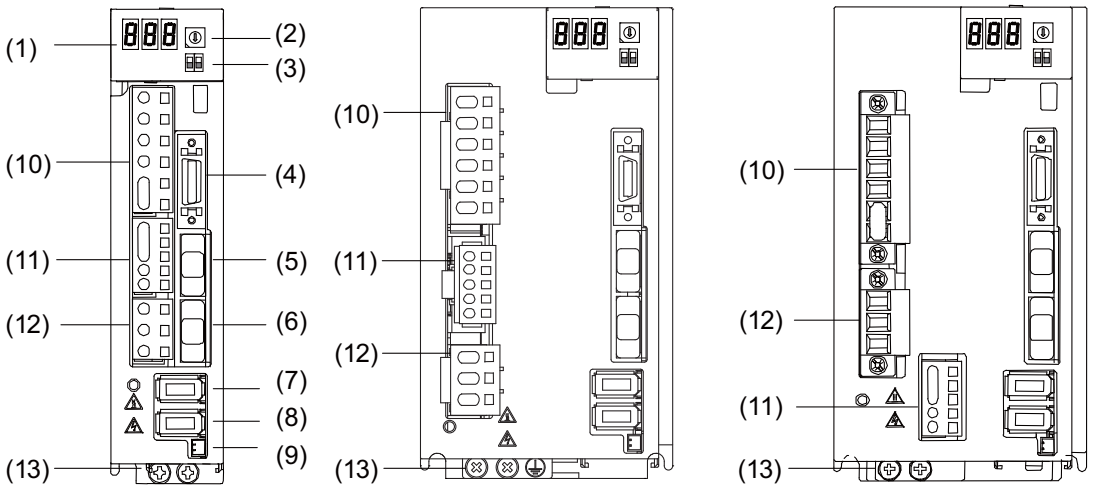


J 6



2-4-5 Explanation of each part

(1) Explanation of each servo drive unit part



MDS-D-SVJ3-03NA/04NA/07NA　　MDS-D-SVJ3-10NA/20NA　　MDS-D-SVJ3-35NA

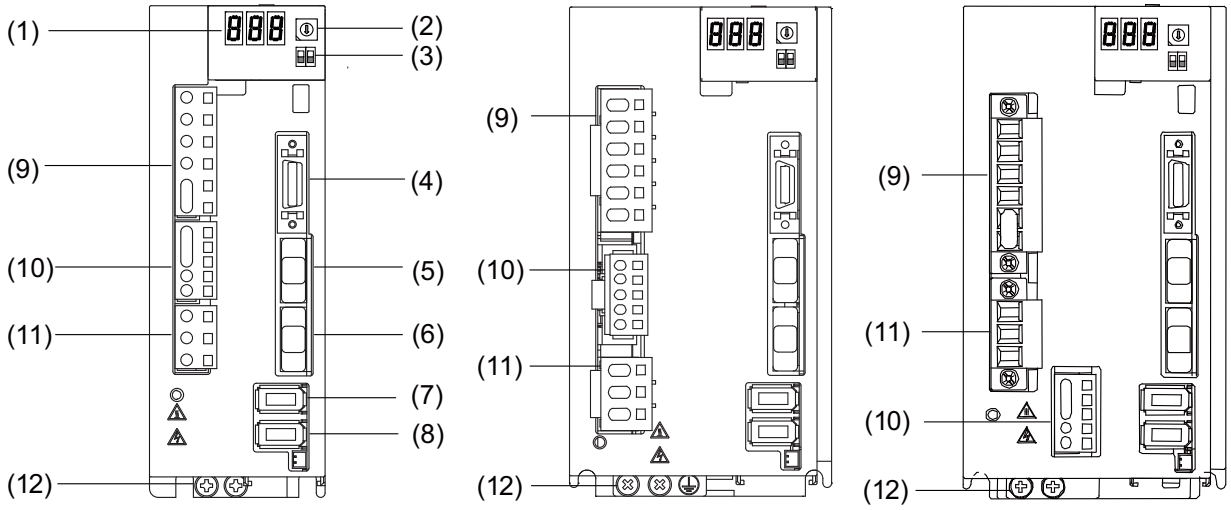
The connector and terminal block layout may differ according to the unit being used. Refer to each unit outline drawing for details.

<Each part name>

		Name		Description	Screw size
(1)	Control circuit	LED	---	Unit status indication LED	---
(2)		SW1	---	Axis No. setting switch	---
(3)		SW2	---	For machine tool builder adjustment: Always OFF (facing bottom)	---
(4)		CN9	---	DI/O or maintenance connector	---
(5)		CN1A	---	NC or master axis optical communication connector	---
(6)		CN1B	---	Slave axis optical communication connector	---
(7)		CN2	---	Motor side detector connection connector	---
(8)		CN3	---	Machine side detector connection connector	---
(9)		BAT	---	Battery connection connector	---
(10)	Main circuit	CNP1	L1,L2,L3 N,P1,P2	L1,L2,L3: 3-phase AC power input N: Test terminal for the manufacturer (Do not connect.) P1,P2: Not used (short-circuit between the P1 and P2.)	---
(11)		CNP2	P,C,D L11,L21	Regenerative resistor connection terminal Control power input terminal (single-phase AC input)	---
(12)		CNP3	U, V, W	Motor power supply output connector (3-phase AC output)	---
(13)		PE	⏚	Grounding terminal	M4 x 10

⚠CAUTION Do not connect the N terminal of CNP1 because it is the test terminal for the manufacturer.

(2) Explanation of each spindle drive unit (0.75 to 3.7kW) part



MDS-D-SPJ3-075NA MDS-D-SPJ3-22NA MDS-D-SPJ3-37NA

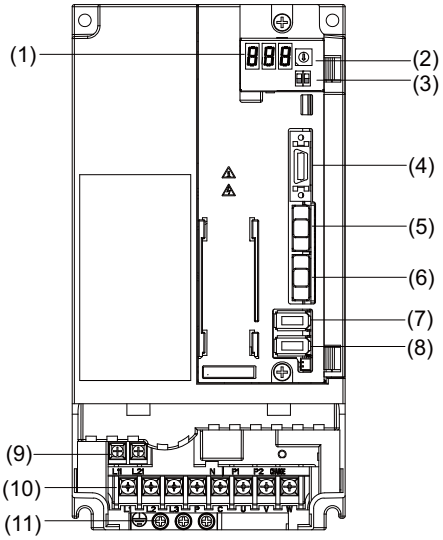
The connector and terminal block layout may differ according to the unit being used. Refer to each unit outline drawing for details.

<Each part name>

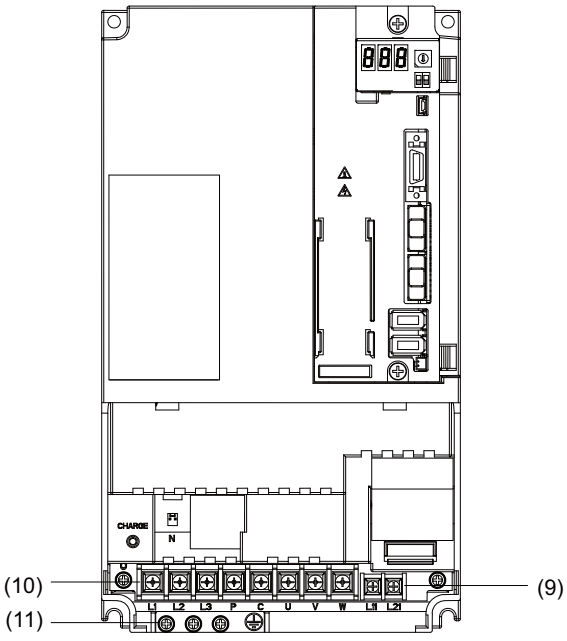
		Name		Description	Screw size
(1)	Control circuit	LED	---	Unit status indication LED	---
(2)		SW1	---	Axis No. setting switch	---
(3)		SW2	---	For machine tool builder adjustment: Always OFF (facing bottom)	---
(4)		CN9	---	DI/O or maintenance connector	---
(5)		CN1A	---	NC or master axis optical communication connector	---
(6)		CN1B	---	Slave axis optical communication connector	---
(7)		CN2	---	Motor side detector connection connector	---
(8)		CN3	---	Machine side detector connection connector	---
(9)	Main circuit	CNP1	L1,L2,L3 N,P1,P2	L1,L2,L3: 3-phase AC power input N: Test terminal for the manufacturer (Do not connect.) P1,P2: Not used (short-circuit between the P1 and P2.)	---
(10)		CNP2	P,C,D L11,L21	Regenerative resistor connection terminal Control power input terminal (single-phase AC input)	---
(11)		CNP3	U, V, W	Motor power output terminal (3-phase AC output)	---
(12)		PE	⏚	Grounding terminal	M4×10

⚠ CAUTION Do not connect the N terminal of CNP1 because it is the test terminal for the manufacturer.

(3) Explanation of each spindle drive unit (5.5 to 11kW) part



MDS-D-SPJ3-55NA/75NA



MDS-D-SPJ3-110NA

The connector and terminal block layout may differ according to the unit being used. Refer to each unit outline drawing for details.

<Each part name>

		Name		Description	Screw size
(1)	Control circuit	LED	---	Unit status indication LED	---
(2)		SW1	---	Axis No. setting switch	---
(3)		SW2	---	For machine tool builder adjustment: Always OFF (facing bottom)	---
(4)		CN9	---	DI/O or maintenance connector	---
(5)		CN1A	---	NC or master axis optical communication connector	---
(6)		CN1B	---	Slave axis optical communication connector	---
(7)		CN2	---	Motor side detector connection connector	---
(8)		CN3	---	Machine side detector connection connector	---
(9)	Main circuit	TE2	L11,L21	Control power input terminal (single-phase AC input)	M3.5×6
(10)		TE1	L1,L2,L3 P,C U, V, W	L1,L2,L3: 3-phase AC power input P,C: Regenerative resistor connection terminal U,V,W: Motor power output terminal (3-phase AC output)	M4×10
(11)		PE	⏚	Grounding terminal	M4×10

3

Function Specifications

Contents

3 Function Specifications

Function specifications list

<Servo specification>

Item		MDS-D-V1/V2	MDS-DH-V1/V2	MDS-DM-V3	MDS-DM-SPV2F/3F MDS-DM-SPV2/3	MDS-D-SVJ3
1 Base functions	1-1 Full closed loop control	●	●	-	● (Note2)	●
	1-2 Position command synchronous control	●	●	●	●	●
	1-3 Speed command synchronous control	●	●	-	-	-
	1-4 Distance-coded reference position control	●	●	-	-	-
2 Servo control function	2-1 Torque limit function (stopper function)	●	●	●	●	●
	2-2 Variable speed loop gain control	●	●	●	●	●
	2-3 Gain changeover for synchronous tapping control	●	●	●	●	●
	2-4 Speed loop PID changeover control	●	●	●	●	●
	2-5 Disturbance torque observer	●	●	●	●	●
	2-6 Smooth High Gain control (SHG control)	●	●	●	●	●
	2-7 High-speed synchronous tapping control (OMR-DD control)	●	●	● (Only for 1-axis)	● (Only for 1-axis)	-
	2-8 Dual feedback control	●	●	-	● (Note2)	●
	2-9 HAS control	●	●	●	●	-
3 Compensation control	3-1 Jitter compensation	●	●	●	●	●
	3-2 Notch filter	Variable frequency: 4 Fixed frequency: 1	Variable frequency: 4 Fixed frequency: 1	Variable frequency: 4 Fixed frequency: 1	Variable frequency: 4 Fixed frequency: 1	Variable frequency: 4 Fixed frequency: 1
	3-3 Adaptive tracking-type notch filter	●	●	-	-	-
	3-4 Overshooting compensation	●	●	●	●	●
	3-5 Machine end compensation control	●	●	●	●	●
	3-6 Lost motion compensation type 2	●	●	●	●	●
	3-7 Lost motion compensation type 3	●	●	●	●	●
	3-8 Lost motion compensation type 4	●	●	-	-	-
4 Protection function	4-1 Deceleration control at emergency stop	●	●	●	●	●
	4-2 Vertical axis drop prevention/pull-up control	●	●	●	●	●
	4-3 Earth fault detection	●	●	●	●	●
	4-4 Collision detection function	●	●	●	●	●
	4-5 Safety observation function	●	●	●	●	●
5 Sequence function	5-1 Contactor control function	MDS-D-CV	MDS-DH-CV	MDS-D-CV	●	●
	5-2 Motor brake control function (Note 1)	●	●	●	●	●
	5-3 External emergency stop function	MDS-D-CV	MDS-DH-CV	MDS-D-CV	●	●
	5-4 Specified speed output	●	●	-	-	-
	5-5 Quick READY ON sequence	●	●	●	●	-
6 Diagnosis function	6-1 Monitor output function	●	●	●	●	●
	6-2 Machine resonance frequency display function	●	●	●	●	●
	6-3 Machine inertia display function	●	●	●	●	●
	6-4 Motor temperature display function (Only for linear or direct-drive motor)	●	●	-	-	● (Only for direct-drive motor)

(Note 1) For the multiaxis drive unit, a control by each axis is not available.
It is required to turn the servo of all axes OFF in the drive unit in order to enable a motor brake output.

(Note 2) For the drive unit MDS-DM-SPV2/3, this function is not available.

<Spindle specifications>

Item		MDS-D-SP	MDS-DH-SP	MDS-D-SP2	MDS-DM-SPV2F/3F MDS-DM-SPV2/3	MDS-D-SPJ3
1 Base functions	1-5 Spindle's continuous position loop control	●	●	●	●	●
	1-6 Coil changeover control	●	●	-	●	-
	1-7 Gear changeover control	●	●	●	●	●
	1-8 Orientation control	●	●	●	●	●
	1-9 Indexing control	●	●	●	●	●
	1-10 Synchronous tapping control	●	●	●	●	●
	1-11 Spindle synchronous control	●	●	●	●	●
	1-12 Spindle/C axis control	●	●	●	●	●
	1-13 Proximity switch orientation control	●	●	-	●	●
2 Spindle control functions	2-1 Torque limit function	●	●	●	●	●
	2-2 Variable speed loop gain control	●	●	●	●	●
	2-5 Disturbance torque observer	●	●	-	●	●
	2-6 Smooth High Gain control (SHG control)	●	●	●	●	●
	2-7 High-speed synchronous tapping control (OMR-DD control)	●	●	●	●	-
	2-8 Dual feedback control	●	●	●	●	●
	2-10 Control loop gain changeover	●	●	●	●	●
	2-11 Spindle output stabilizing control	●	●	●	●	●
	2-12 High-response spindle acceleration/deceleration function	●	●	●	●	●
3 Compensation controls	3-1 Jitter compensation	●	●	●	●	●
	3-2 Notch filter	Variable frequency: 4 Fixed frequency: 1	Variable frequency: 4 Fixed frequency: 1	Variable frequency: 4 Fixed frequency: 1	Variable frequency: 4 Fixed frequency: 1	Variable frequency: 4 Fixed frequency: 1
	3-4 Overshooting compensation	●	●	●	●	●
	3-6 Lost motion compensation type 2	●	●	●	●	●
	3-7 Lost motion compensation type 3	●	●	-	-	-
	3-9 Spindle motor temperature compensation function	●	●	●	●	-
4 Protection function	4-1 Deceleration control at emergency stop	●	●	●	●	●
	4-3 Earth fault detection	●	●	●	●	●
	4-5 Safety observation function	●	●	●	●	●
5 Sequence functions	5-1 Contactor control function	MDS-D-CV	MDS-DH-CV	MDS-D-CV	●	●
	5-3 External emergency stop function	MDS-D-CV	MDS-DH-CV	MDS-D-CV	●	●
	5-4 Specified speed output	●	●	●	●	-
	5-5 Quick READY ON sequence	●	●	●	●	-
6 Diagnosis functions	6-1 Monitor output function	●	●	●	●	●
	6-2 Machine resonance frequency display function	●	●	●	●	●
	6-3 Machine inertia display function	●	●	●	●	●
	6-4 Motor temperature display function	●	●	●	●	●
	6-5 Load monitor output function	●	●	●	●	● (Note)
	6-6 Open loop control function	●	●	●	●	●

(Note) The motor output effective value cannot be displayed.

3 Function Specifications

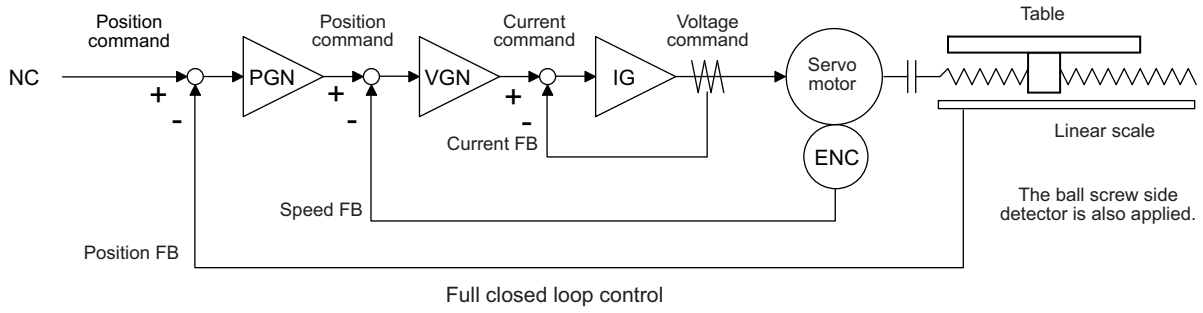
3-1 Base functions

3-1-1 Full closed loop control

The servo control is all closed loop control using the detector's feedback. "Full closed loop control" is the system that directly detects the machine position using a linear scale, whereas the general "semi-closed loop" is the one that detects the motor position.
In a machine that drives a table with a ball screw, the following factors exist between the motor and table end:

(1) Coupling or ball screw table bracket's backlash
(2) Ball screw pitch error

These can adversely affect the accuracy. If the table position of the machine side is directly detected with a linear scale, high-accuracy position control which is not affected by backlash or pitch error is possible.



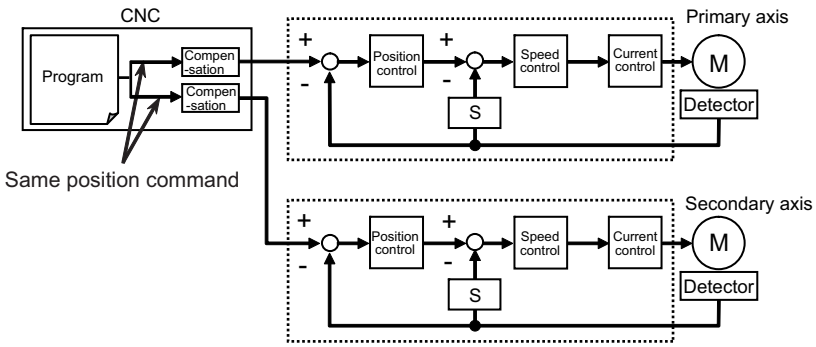
Full closed loop control

3-1-2 Position command synchronous control

This is one of the controls which enable two servo motors to drive the same axis. This is also called "Position tandem control"
The same position command is issued to the 2-axis servo control, and the control is carried out according to each axis' position and speed feedbacks.

<Features>

(1) The position commands in which machine's mechanical errors (pitch error, backlash, etc.) have been compensated, can be output to each axis.
(2) Each axis conducts independent position control, therefore the machine posture can be kept constant.
(3) Deviation between the two axes is always monitored, and if excessive, the alarm is detected.

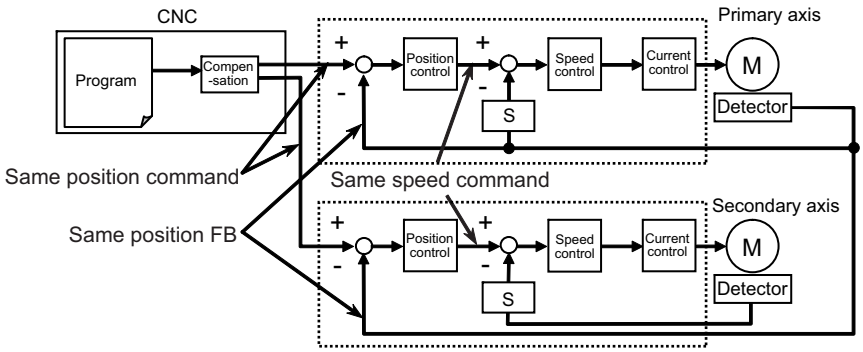


3-1-3 Speed command synchronous control

This is one of the controls which enable two servo motors to drive the same axis. This is also called "Speed tandem control".
The same position command is issued to the 2-axis servo control, and the control is carried out according to each axis' position and speed feedbacks.
This function is usually used when the control is performed with one linear scale during the full closed loop control.

<Features>

(1) The position commands in which machine's mechanical errors (pitch error, backlash, etc.) have been compensated, can be output to each axis.
(2) Each axis conducts independent position control, therefore the machine posture can be kept constant.
(3) Deviation between the two axes is always monitored, and if excessive, the alarm is detected

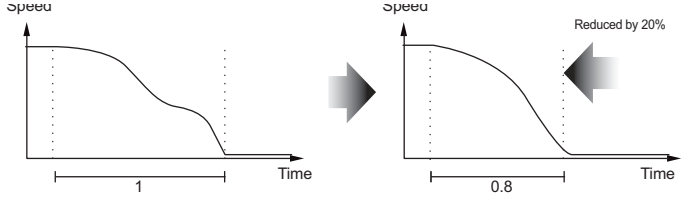


3-1-4 Distance-coded reference position control

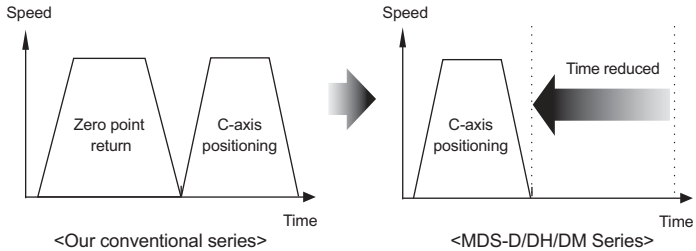
This is the function to establish the reference point from axis movements of the reference points using a scale with distance-coded reference mark.
Since it is not necessary to move the axis to the reference point, the axis movement amount to establish the reference point can be reduced.
No dog is used as the position is calculated using reference marks. This function can not be used for the linear servomotor and direct-drive motor.
If the distance-coded reference check function is used to verify the motor end detector data, select a battery option before setting the parameter.

3-1-5 Spindle's continuous position loop control

Under this control, position loop control is always applied to spindle, including when speed command is issued (in cutting). There is no need for control changeover nor zero point return during orientation and C axis control changeover. Therefore, the operation can be completed in a shorter time than the previous. In acceleration/deceleration with S command, the acceleration/deceleration and orientation are always controlled with the spindle motor's maximum torque.



<Our conventional series> Orientation <MDS-D/DH/DM Series>



<Our conventional series> <MDS-D/DH/DM Series>

C-axis changeover

3-1-6 Coil changeover control

A signal output from the spindle drive unit controls the changeover of the low-speed and high-speed specification coils in a spindle motor.
The drive unit automatically outputs the coil changeover sequence in accordance with the motor speed.

3-1-7 Gear changeover control

This function enables a spindle motor to perform both high-speed light cutting and low-speed heavy cutting by changing the gear ratio between the motor and spindle.
The gear change is carried out while the spindle is not running.

3-1-8 Orientation control

This control enables a spindle motor to stop at a designated angle when the motor is rotating at a high-speed with a speed command. This control is used for exchanging the tools in machining centers and performing index positioning in lathes, etc.

3-1-9 Indexing control

This control enables positioning of a spindle motor at an arbitrary angle (in increments of 0.01 degrees) from the orientation stop position. This control is used for positioning in lathes for hole drilling, etc.

3-1-10 Synchronous tapping control

Under synchronous tapping control, spindle control is completely synchronized with Z axis servo control, and Z axis is accurately fed by one screw pitch in accordance with one tap revolution. The tap is completely fixed to the spindle head. As a result, feed pitch error is less likely to occur, which allows high-speed, high-accuracy and high-durable tapping.

3-1-11 Spindle synchronous control

This control enables two spindles to run at the same speed. A spindle being driven with a speed command is synchronized with another spindle at a constant rate or acceleration/deceleration rate.
This control is applied such as when a workpiece is transferred between two rotating chucks in lathe or a workpiece is held with two chucks.

3-1-12 Spindle/C axis control

An axis rotating about Z axis is called C axis, whose rotation direction is normally the same as of spindle. This function enables high-accuracy spindle control including interpolation control, like servo axis, when a high-resolution position detector is attached to the spindle motor.

3-1-13 Proximity switch orientation control

Orientation control is carried out based on the leading edge position of the proximity switch output signal (ON/OFF).

3-2 Servo/Spindle control functions

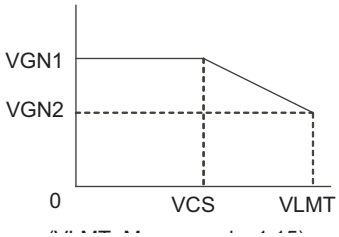
3-2-1 Torque limit function

This control suppresses the motor output torque with the parameter values (SV013, SV014).
This function is used for stopper positioning control and stopper reference position establishment, by switching the two setting values.

3-2-2 Variable speed loop gain control

< Servo >

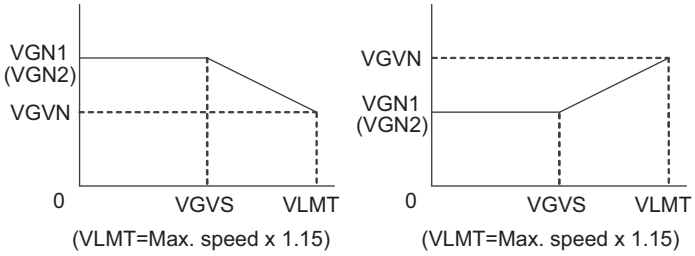
If disturbing noise occurs when the motor is rotating at a high speed, such as during rapid traverse, the high speed loop gain during high-speed rotation can be lowered with this function.



VGN1:SV005
VGN2:SV006
VCS:SV029
VLMT: Servomotor maximum speed x 1.15

< Spindle >

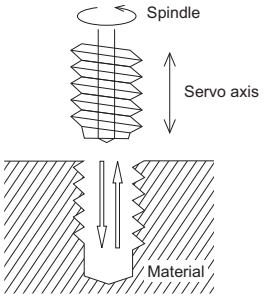
For a high-speed spindle of machining center etc., adequate response can be ensured with this function by suppressing noise and vibration at low speeds and increasing the speed loop gain at high-speeds.



VGN1:SP005
VGN2:SP008
VGVN:SP073
VGVS:SP074
VLMT: Spindle maximum speed x 1.15

3-2-3 Gain changeover for synchronous tapping control

SV003, SV004 and SV057 are used as the position loop gain for normal control. Under synchronous tapping control, SV049, SV050 and SV058 are used instead to meet the spindle characteristics.



3-2-4 Speed loop PID changeover control

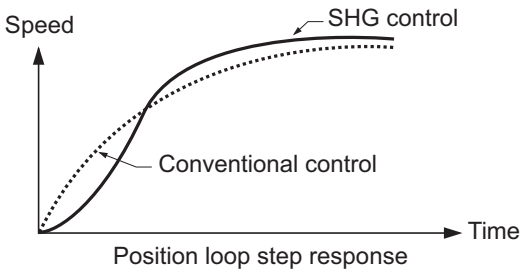
This function is used under full-closed loop control. Normally, machine-end position tracking delays compared with the motor-end position.
Under full-closed position loop control, machine-end position is used for position feedback. Therefore, the motor-end position tends to advance too much, which may cause overshooting of the machine-end position. This function can suppress the generation of overshoot by adding the D (delay) control to the speed control, which is normally controlled with PI (proportional integral), in order to weaken the PI control after the position droop becomes 0.

3-2-5 Disturbance torque observer

The effect caused by disturbance, frictional resistance or torsion vibration during cutting can be reduced by estimating the disturbance torque and compensating it.

3-2-6 Smooth High Gain control (SHG control)

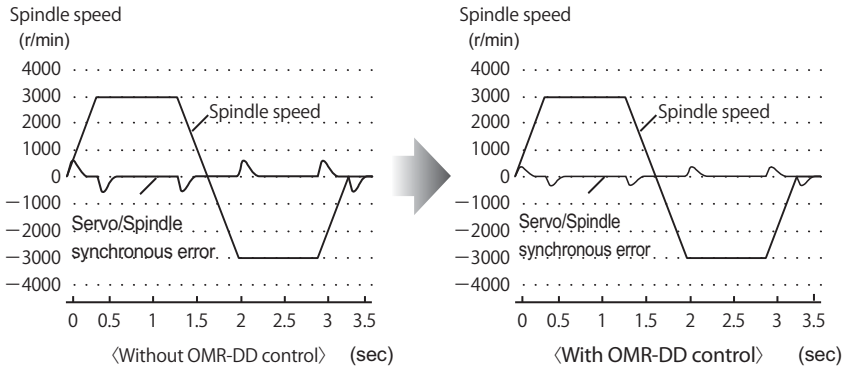
A high-response control and smooth control (reduced impact on machine) were conventionally conflicting elements; however, SHG control enables the two elements to function simultaneously by controlling the motor torque (current FB) with an ideal waveform during acceleration/deceleration.



Position loop step response

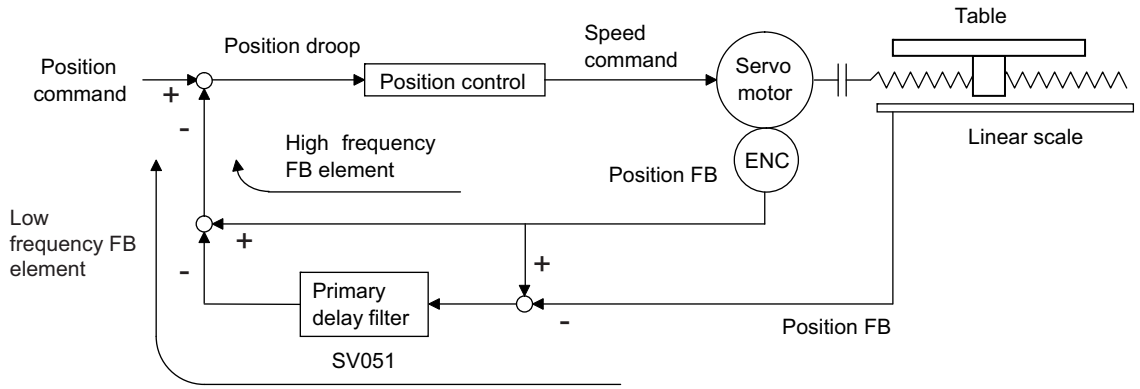
3-2-7 High-speed synchronous tapping control (OMR-DD control)

Servo drive unit detects the spindle position, and compensates the synchronization errors. This control enables more accurate tapping than the previous.



3-2-8 Dual feedback control

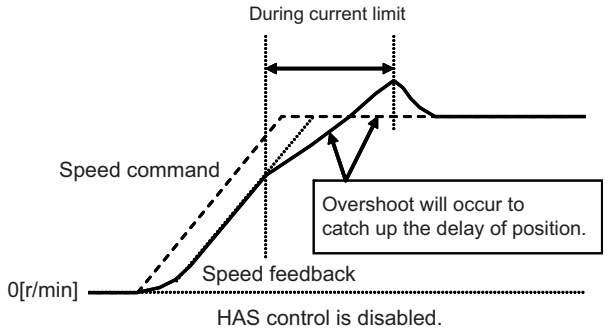
This function is used under full-closed loop control.
When a linear scale is used, the machine-end position, such as a table, is directly detected, which may render the position loop control unstable.
With this control, however, high-frequency components are eliminated from the machine-end feedback signals, which will lead to stable control.

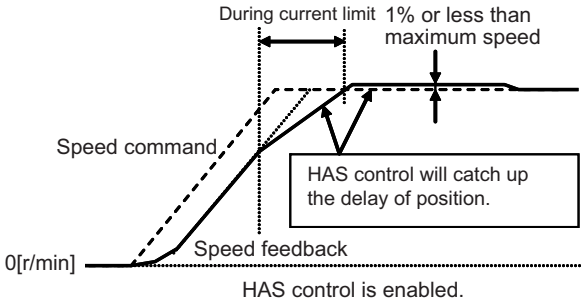


Dual feedback control

3-2-9 HAS control

If the torque output during acceleration/deceleration is close to the servo motor's maximum torque, the motor cannot accelerate with the commanded time constant when the torque is saturated due to input voltage fluctuation, etc. As a result, speed overshoot occurs when a constant speed command is issued, because the position droop for the delay is canceled.
With HAS control, however, this overshoot is smoothened so that the machine operation can be stable.





3-2-10 Control loop gain changeover

Position loop gain and speed loop gain are switched between non-interpolation mode, which is used during speed command, and interpolation mode, which is used during synchronous tapping and C axis control. By switching these gains, optimum control for each mode can be realized.

3-2-11 Spindle output stabilizing control

Spindle motor's torque characteristic is suppressed due to voltage saturation in the high-speed rotation range, therefore the current control responsiveness significantly degrades, which may cause excessive current.
With this control, however, the current and flux commands are compensated to avoid the voltage saturation so that the current control responsiveness will not degrade.

3-2-12 High-response spindle acceleration/deceleration function

This function enables reduction of the spindle motor's setting time (from when the command value becomes 0 until when the motor actually stops) without being affected by the position loop gain, when the spindle motor stops under deceleration stop control using the S command.
This function is not active when the spindle is stopped while performing position control, such as orientation control and synchronous tapping control.

3-3 Compensation controls

3-3-1 Jitter compensation

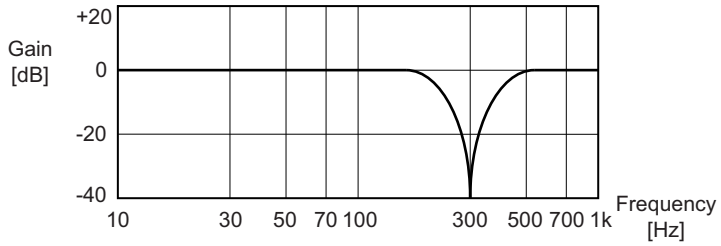
The load inertia becomes much smaller than usual if the motor position enters the machine backlash when the motor is stopped.
Because this means that an extremely large VGN1 is set for the load inertia, vibration may occur.
Jitter compensation can suppress the vibration that occurs at the motor stop by ignoring the backlash amount of speed feedback pulses when the speed feedback polarity changes.

3-3-2 Notch filter

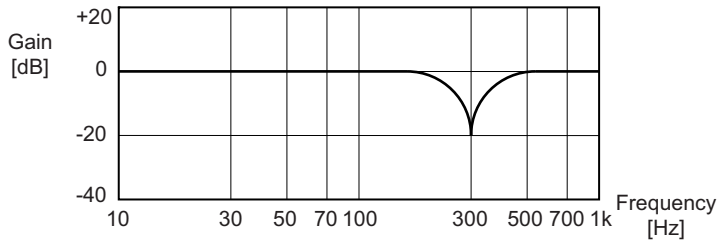
This filter can damp vibrations of servo torque commands at a specified frequency.
Machine vibrations can be suppressed by adjusting the notch filter frequency to the machine's resonance frequency.
Filter depth adjustment is also available that allows stable control even when the filter is set to an extremely low frequency.

<Specifications>

Notch filter	Frequency	Depth compensation
Notch filter 1	50Hz to 2250Hz	Enabled
Notch filter 2	50Hz to 2250Hz	Enabled
Notch filter 3	Fixed at 1125Hz	Disabled
Notch filter 4	50Hz to 2250Hz	Enabled
Notch filter 5	50Hz to 2250Hz	Enabled



Example of filter characteristic set to 300Hz



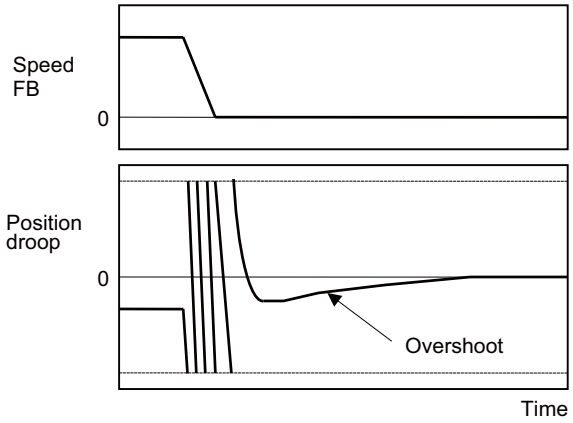
For shallow setting by additionally using the depth compensation at 300Hz

3-3-3 Adaptive tracking-type notch filter

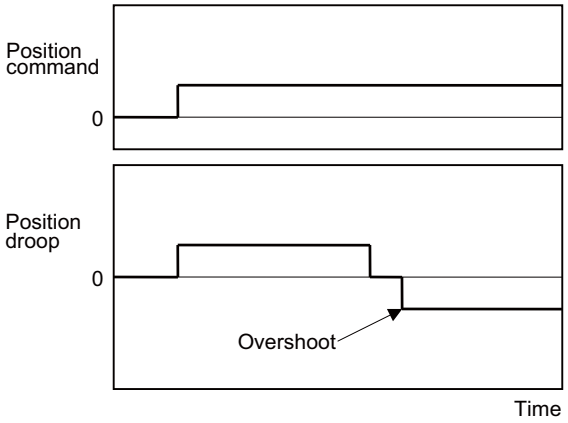
Machine's specific resonance frequency tends to change due to aged deterioration or according to machine's operation conditions. Therefore, the frequency may be deviated from the filter frequency set at the initial adjustment. With adaptive tracking-type notch filter, resonance point fluctuation due to the machine's condition change is estimated using the vibration components of the current commands, and effective notch filter frequency, which has been deviated from the setting value, is automatically corrected to suppress the resonance.

3-3-4 Overshooting compensation

The phenomenon when the machine position goes past or exceeds the command during feed stopping is called overshooting.
In OVS compensation, the overshooting is suppressed by subtracting the torque command set in the parameters when the motor stops.



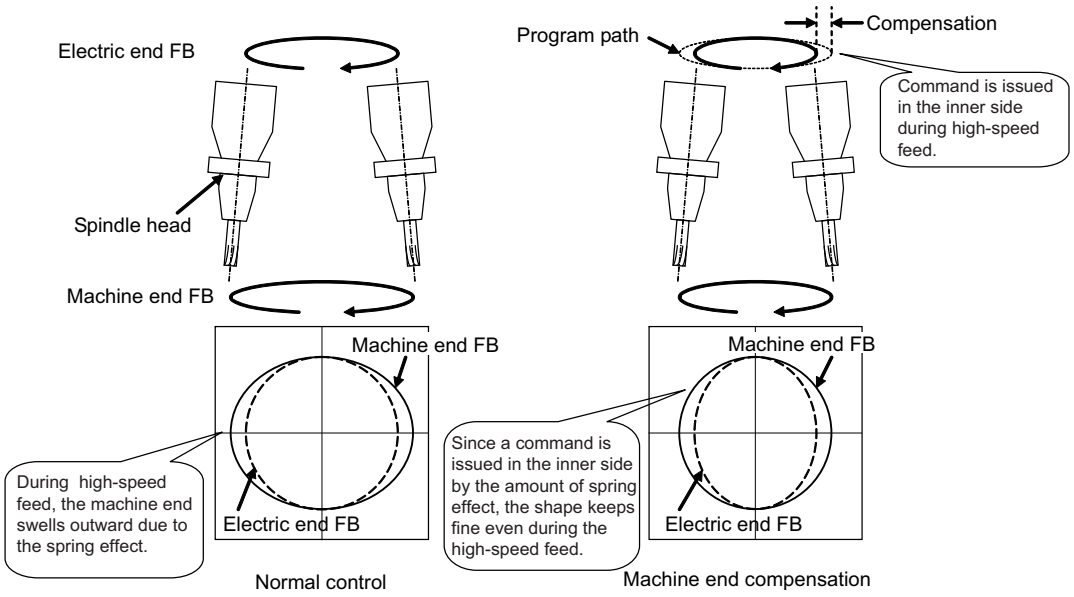
[1] Overshooting during rapid traverse settling



[2] Overshooting during pulse feed

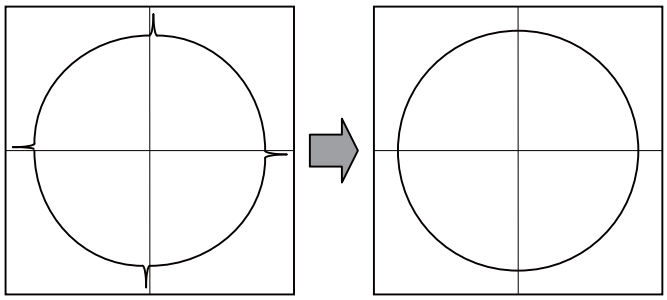
3-3-5 Machine end compensation control

The shape of the machine end during high-speed and high-speed acceleration operation is compensated by compensating the spring effect from the machine end to the motor end.
The shape may be fine during low-speed operation. However, at high speeds, the section from the machine end to the outer sides could swell. This function compensates that phenomenon.



3-3-6 Lost motion compensation type 2

Servo motor always drives the machine opposing to the frictional force, and the torque which is required to oppose the friction during the axis movement is outputted by I control (Integral control) of the speed loop PI control. When the movement direction is changed, the frictional force works in the opposite direction momentarily, however, the machine will stop while the command torque is less than the frictional force as it takes some time to reverse the command torque in I control.
When the movement direction is changed, the frictional force works in the opposite direction momentarily, however, the machine will stop while the command torque is less than the frictional force as it takes some time to reverse the command torque in I control.
With the this lost motion compensation function improves the accuracy worsened by the stick motion.



No compensation　　With compensation

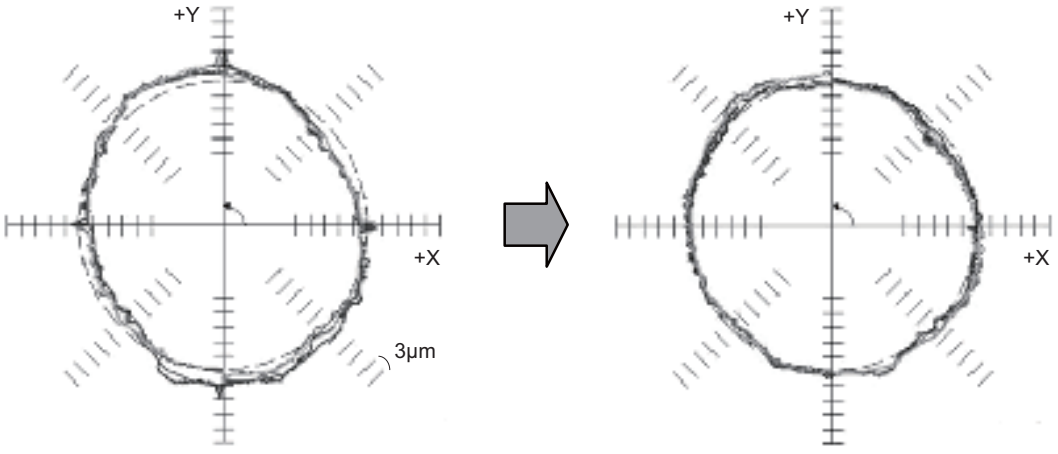
3-3-7 Lost motion compensation type 3

For a machine model where the travel direction is reversed, the compensation in accordance with the changes in the cutting conditions is enabled by also considering the spring component and viscosity component in addition to the friction.
This function can be used to accommodate quadrant projection changes that accompany feed rate and circular radius changes which could not be compensated by Lost motion compensation type 2.

1.Mechanical spring elements can't be ignored.
2.Changes between static and dynamic frictions are wide and steep.

Not only frictions but spring element and viscosity element can be compensated, thus quadrant protrusions are suppressed within a wide band.

Conventional control can't perform enough compensation.



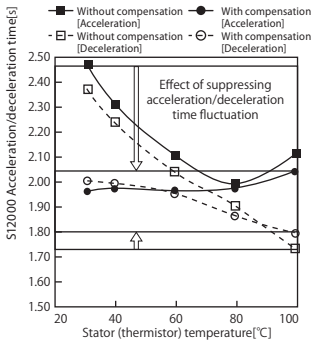
Conventional compensation control　　Lost motion compensation control type 3

3-3-8 Lost motion compensation type 4

When the difference between static and dynamic friction is large, the friction torque changes sharply at the inversion of the travel direction. When the lost motion type 4 is used together with the type 2 or type 3, the acute change of the friction torque is compensated so that the path accuracy at the travel direction inversion can be enhanced.

3-3-9 Spindle motor temperature compensation function

As for the low-temperature state of the IM spindle motor, the output characteristic may deteriorate in comparison with the warm-up state and the acceleration/deceleration time may become long, or the load display during cutting may become high immediately after operation. This function performs the control compensation depending on the motor temperature with the thermistor built into the spindle motor and suppresses the output characteristic deterioration when the temperature is low. Temperature compensation function is not required for IPM spindle motor in principle.



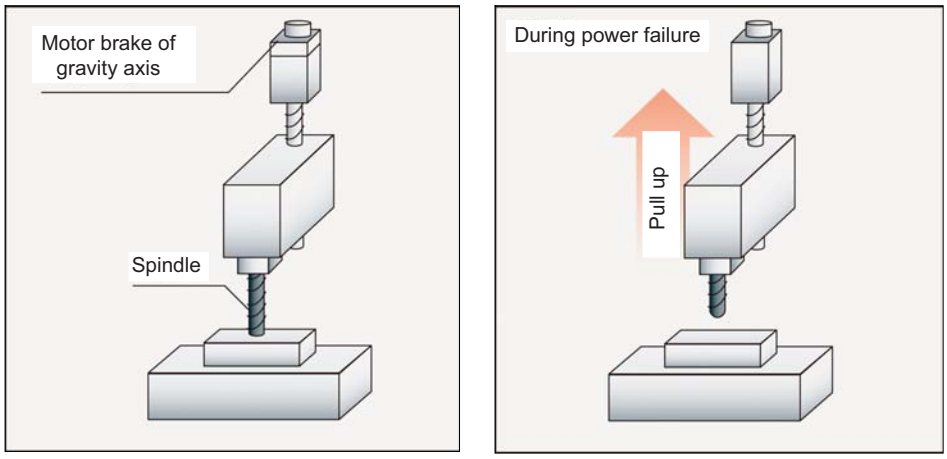
3-4 Protection function

3-4-1 Deceleration control at emergency stop

When an emergency stop (including NC failure, servo alarm) occurs, the motor will decelerate following the set time constant while maintaining the READY ON state.
READY will turn OFF and the dynamic brakes will function after stopping. The deceleration stop can be executed at a shorter distance than the dynamic brakes.

3-4-2 Vertical axis drop prevention/pull-up control

If the READY OFF and brake operation are commanded at same time when an emergency stop occurs, the axis drops due to a delay in the brake operation.
The no-control time until the brakes activate can be eliminated by delaying the servo READY OFF sequence by the time set in the parameters.
Always use this function together with deceleration control.
When an emergency stop occurs in a vertical machining center, the Z axis is slightly pulled upwards before braking to compensate the drop of even a few μm caused by the brake backlash.



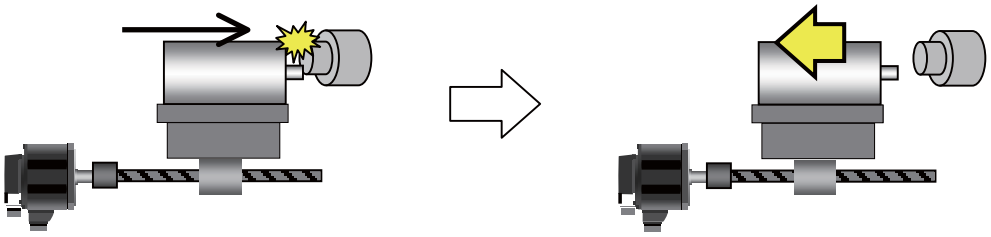
3-4-3 Earth fault detection

When an emergency stop is canceled, the earth fault current is measured using the power module's special switching circuit before Servo ready ON.
Specifying the faulty axis is possible in this detection, as the detection is carried out for each axis.

3-4-4 Collision detection function

Collision detection function quickly detects a collision of the motor shaft, and decelerates and stops the motor. This suppresses the generation of an excessive torque in the machine tool, and helps to prevent an abnormal state from occurring.Impact at a collision will not be prevented by using this collision detection function, so this function does not necessarily guarantee that the machine tool will not be damaged or that the machine accuracy will be maintained after a collision.
The same caution as during regular operation is required to prevent the machine from colliding.

Collision detection function outline

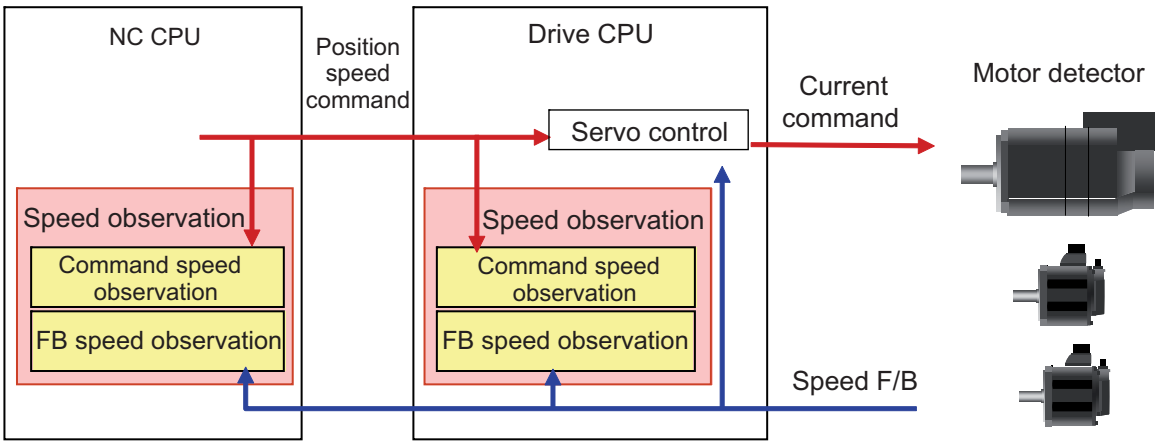


(a) A collision of machine is detected.

(b) A retracting torque is generated.
The collision of machine is reduced.

3-4-5 Safety observation function

This function is aimed at allowing a safety access to the machine's working part by opening the protection door, etc. without shutting the power for saving the setup time.
Both the NC control system and drive system (servo and spindle drive units) doubly observe the axis feed rate so that it will not exceed the safety speed. If it exceeds the set safety speed, emergency stop occurs and the power is shut OFF.



3-5 Sequence functions

3-5-1 Contactor control function

With this function, the contactor ON/OFF command is output from the power supply unit (or servo/spindle drive unit for integrated type) based on the judgement as to whether it is in emergency stop, emergency stop cancel, spindle deceleration and stop or vertical axis drop prevention control, etc.

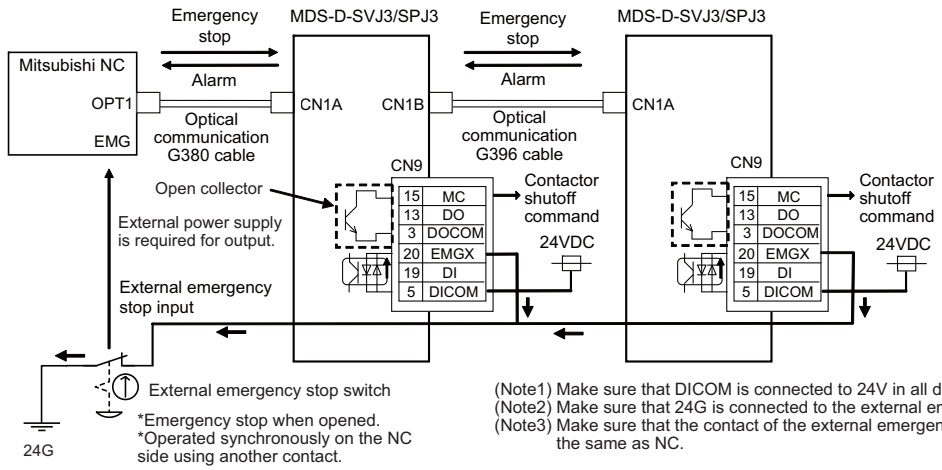
3-5-2 Motor brake control function

With this function, the brake ON/OFF command is output from the servo drive unit based on the judgement as to whether it is in emergency stop, emergency stop cancel or vertical axis drop prevention/pull-up control, etc.
When a multiaxis drive unit is connected, all the axes are simultaneously controlled.

3-5-3 External emergency stop function

Besides the emergency stop input from the NC, double-protection when an emergency stop occurs can be provided by directly inputting an external emergency stop, which is a second emergency stop input, to the power supply unit (servo/spindle drive unit for integrated type).
Even if the emergency stop is not input from NC for some reason, the contactors will be activated by the external emergency stop input, and the power can be shut off.

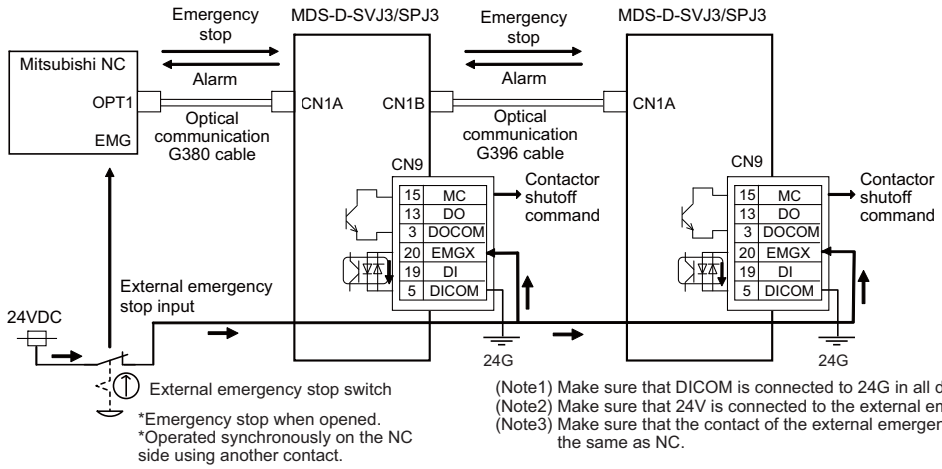
(1) When DICOM is connected to 24V



(Note1) Make sure that DICOM is connected to 24V in all drive systems.
(Note2) Make sure that 24G is connected to the external emergency stop switch.
(Note3) Make sure that the contact of the external emergency stop switch is not the same as NC.

Select the polarity of DICOM

(2) When DICOM is connected to 24G



(Note1) Make sure that DICOM is connected to 24G in all drive systems.
(Note2) Make sure that 24V is connected to the external emergency stop switch.
(Note3) Make sure that the contact of the external emergency stop switch is not the same as NC.

3-5-4 Specified speed output

This function is to output a signal that indicates whether the machine-end speed has exceeded the speed specified with the parameter.
With this function, the protection door, etc. can be locked to secure the machine operator when the machine-end speed has exceeded the specified speed. This function can also be used for judging whether the current machine-end speed is higher than the specified speed.

3-5-5 Quick READY ON sequence

With this function, the charging time during READY ON is shortened according to the remaining charge capacity of the power supply unit. When returning to READY ON status immediately after the emergency stop input, the charging time can be shortened according to the remaining charge capacity and the time to READY ON is shortened.

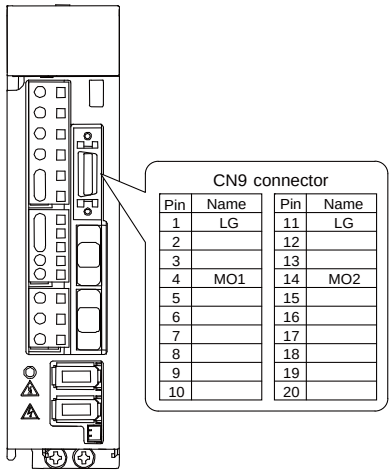
3-6 Diagnosis function

3-6-1 Monitor output function

<Servo drive unit>

Drive unit has a function to D/A output the various control data. The servo adjustment data required for setting the servo parameters to match the machine can be D/A output. Measure using a high-speed waveform recorder, oscilloscope, etc.

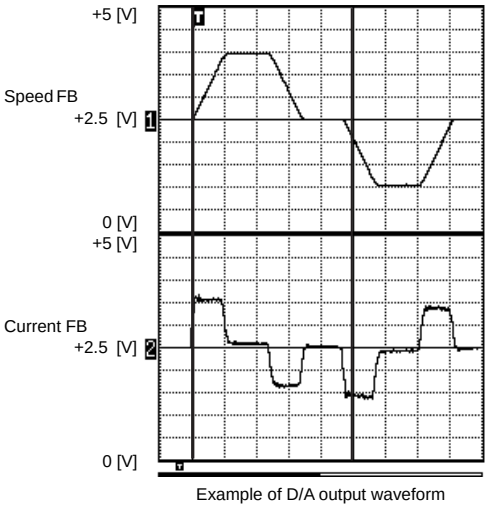
(1) D/A output specifications



MDS-D-SVJ3

Item	Explanation
No. of channels	2ch
Output cycle	0.8ms (min. value)
Output precision	10bit
Output voltage range	0V to 2.5V (zero) to +5V
Output magnification setting	-32768 to 32767 (1/100-fold)
Output pin (CN9 connector)	MO1 = Pin 4, MO2 = Pin 14, LG = Pin 1,11

When the output data is 0, the offset voltage is 2.5V. If there is an offset voltage, adjust the zero level position in the measuring instrument side.



Example of D/A output waveform

(2) Output data settings
(Standard output)

【#2261】 SV061 DA1NO D/A output ch1 data No.

Input the data number you wish to output to the D/A output channel 1.
When using the 2-axis drive unit, set "-1" to the axis that the data will not be output.

---Setting range---
-1 to 127

【#2262】 SV062 DA2NO D/A output ch2 data No.

Input the data number you wish to output to the D/A output channel 2.
When using the 2-axis drive unit, set "-1" to the axis that the data will not be output.

---Setting range---
-1 to 127

No.	Output data	Standard output unit		Output cycle
		Linear axis	Rotary axis	
-1	D/A output not selected	For 2-axis drive unit (MDS-D/DH-V2). Set the parameters to another axis in the drive unit that is not D/A output.		
0	Commanded rotation speed	1000(r/min)/V		0.8ms
1	Motor rotation speed	1000(r/min)/V		0.8ms
2	Torque command	Motor stall rated ratio 100%/V		0.8ms
3	Torque feedback	Motor stall rated ratio 100%/V		0.8ms
6	Effective current command	100%/V		0.8ms
7	Effective current feedback	100%/V		0.8ms
8	Machine vibration frequency	500Hz/V		0.8ms
9	HAS control droop cancel amount	1mm/V	1°/V	0.8ms
30	Collision detection estimated torque	100%/V		0.8ms
31	Collision detection disturbance estimated torque	100%/V		0.8ms
32	Estimated load inertia ratio or moving sections gross weight	100%/V or 100kg/V (Note)		0.8ms
35	Disturbance observer estimated disturbance torque	100%/V		0.8ms
50	Position droop	1μm/V	1/1000°/V	0.8ms
51	Position command	1μm/V	1/1000°/V	0.8ms
52	Position feedback	1μm/V	1/1000°/V	0.8ms
53	Position FΔT	1μm/s/V	1/1000°/s/V	0.8ms
54	Deviation from ideal position (considering servo tracking delay)	1μm/V	1/1000°/V	0.8ms
60	Position droop	1mm/V	1°/V	0.8ms
61	Position command	1mm/V	1°/V	0.8ms
62	Position feedback	1mm/V	1°/V	0.8ms
63	Position FΔT	1mm/s/V	1°/s/V	0.8ms
64	Deviation from ideal position (considering servo tracking delay)	1mm/V	1°/V	0.8ms
70	Position droop	1m/V	1000°/V	0.8ms
71	Position command	1m/V	1000°/V	0.8ms
72	Position feedback	1m/V	1000°/V	0.8ms
73	Position FΔT	1m/s/V	1000°/s/V	0.8ms
74	Deviation from ideal position (considering servo tracking delay)	1m/V	1000°/V	0.8ms
126	Saw tooth wave	0V to 5V		0.8ms
127	2.5V test data	2.5V		0.8ms

(Note) The estimated load inertia ratio (unit: 100%/V) is applied for the rotary motor, and the moving sections gross weight (unit: 100kg/V) for the linear motor.

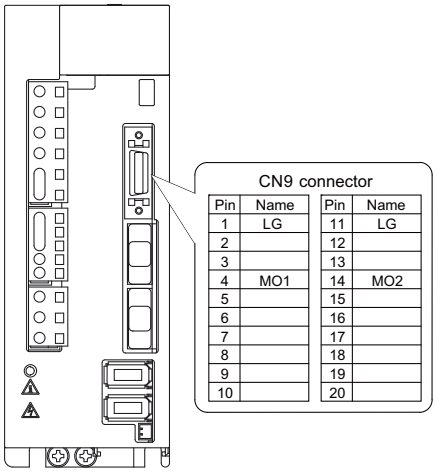
(Servo control signal)

Servo control input (NC to Servo)			Servo control output (Servo to NC)		
No.	Details		No.	Details	
16384	Servo control input 1-0	READY ON command	16480	Servo control output 1-0	In READY ON
16385	Servo control input 1-1	Servo ON command	16481	Servo control output 1-1	In servo ON
16388	Servo control input 1-4	Position loop gain change-over command	16484	Servo control output 1-4	In position loop gain change-over
16390	Servo control input 1-6	Excessive error detection width changeover command	16486	Servo control output 1-6	In excessive error detection width changeover
16391	Servo control input 1-7	Alarm reset command	16487	Servo control output 1-7	In alarm
16392	Servo control input 1-8	Current limit selection command	16488	Servo control output 1-8	In current limit selection
			16492	Servo control output 1-C	In in-position
			16493	Servo control output 1-D	In current limit
			16494	Servo control output 1-E	In absolute position data loss
			16495	Servo control output 1-F	In warning
			16496	Servo control output 2-0	Z phase passed
			16499	Servo control output 2-3	In zero speed
			16503	Servo control output 2-7	In external emergency stop
16416	Servo control input 3-0	Control axis detachment command	16512	Servo control output 3-0	In control axis detachment

< Spindle drive unit >

Drive unit has a function to D/A output each control data. The spindle adjustment data required to set the spindle parameters matching the machine can be D/A output. The data can be measured with a high-speed waveform recorder or oscilloscope, etc.

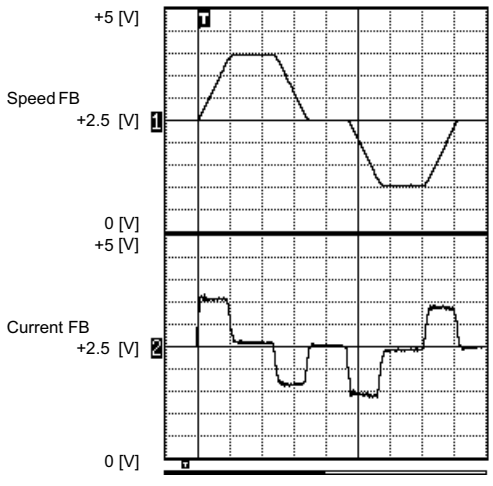
(1) D/A output specifications



MDS-D-SPJ3

Item	Explanation
No. of channels	2ch
Output cycle	0.8ms (min. value)
Output precision	10bit
Output voltage range	0V to 2.5V (zero) to +5V
Output magnification setting	-32768 to 32767 (1/100-fold)
Output pin (CN9 connector)	MO1 = Pin 4, MO2 = Pin 14, LG = Pin 1,11

When the output data is 0, the offset voltage is 2.5V. If there is an offset voltage, adjust the zero level position in the measuring instrument side.



Example of D/A output waveform

(2) Output data settings
(Standard output)

【#13125】 SP125 DA1NO D/A output ch1 data No.

Input the desired data number to D/A output channel.

---Setting range---
-32768 to 32767

【#13126】 SP126 DA2NO D/A output ch2 data No.

Input the desired data number to D/A output channel.

---Setting range---
-32768 to 32767

No.	Output data	Output unit for standard setting	Output cycle
-1	D/A output stop	-	
0	Commanded motor rotation speed	1000(r/min)/V	0.8ms(min)
1	Motor rotation speed	1000(r/min)/V	0.8ms(min)
2	Torque current command	Short time rated ratio 100%/V	0.8ms(min)
3	Torque current feedback	Short time rated ratio 100%/V	0.8ms(min)
35	Disturbance observer estimated disturbance torque	Short time rated torque current value ratio 100%/V	0.8ms(min)
50	Position droop	1/1000°/V	0.8ms(min)
51	Position command	1/1000°/V	0.8ms(min)
52	Position feedback	1/1000°/V	0.8ms(min)
53	Position F ⊿T	1/1000°/s/V	0.8ms(min)
54	Deviation from ideal position (considering spindle tracking delay)	1/1000°/V	0.8ms(min)
60	Position droop	1°/V	0.8ms(min)
61	Position command	1°/V	0.8ms(min)
62	Position feedback	1°/V	0.8ms(min)
63	Position F ⊿T	1°/s/V	0.8ms(min)
64	Deviation from ideal position (considering spindle tracking delay)	1°/V	0.8ms(min)
70	Position droop	1000°/V	0.8ms(min)
71	Position command	1000°/V	0.8ms(min)
72	Position feedback	1000°/V	0.8ms(min)
73	Position F ⊿T	1000°/s/V	0.8ms(min)
74	Deviation from ideal position (considering spindle tracking delay)	1000°/V	0.8ms(min)
110	3.0V output load meter (Note)	40%/V, 120%/3V	0.8ms(min)
126	Saw tooth wave	0V to 5V	0.8ms(min)
127	2.5V test data output	2.5V	0.8ms(min)

(Note) Load meter displays "100%(=2.5V)" when the control power turns ON and the NC is starting. After the NC has been run, it displays "0%(=0V%)".

(Special output)

The result of PLG(TS5690) installation accuracy diagnosis is output to D/A output. D/A output magnification:SP127(DA1MPY) and SP128(DA2MPY) is 0.

PLG installation diagnosis function can be enabled during the rotation, when open loop control is enabled:SP018(SPEC2)/bit1=1.

D/A output No.	Details	Description
120	Motor end PLG installation Gap diagnosis	Motor end PLG installation gap is diagnosed. When the gap is good, 2.5V is output. When the gap is excessive, 2.5V+1V is output. When the gap is too small, 2.5V-1V is output.
121	Motor end PLG installation All errors diagnosis	Motor end PLG installation error (including the gap) is diagnosed. When the installation is good, 2.5V is output. When the installation is incorrect, 2.5V+1V is output.
122	Spindle end PLG installation Gap diagnosis	Spindle end PLG installation gap is diagnosed. Diagnostic procedure is the same as that of motor end PLG.
123	Spindle end PLG installation All errors diagnosis	Spindle end PLG installation error (including the gap) is diagnosed. Diagnostic procedure is the same as that of motor end PLG.

(Spindle control signal)

Spindle control input (NC to Spindle)			Spindle control output (Spindle to NC)		
No.	Details		No.	Details	
16384	Spindle control input 1-0	READY ON command	16480	Spindle control output 1-0	In ready ON
16385	Spindle control input 1-1	Servo ON command	16481	Spindle control output 1-1	In servo ON
16391	Spindle control input 1-7	Alarm reset command	16487	Spindle control output 1-7	In alarm
16392	Spindle control input 1-8	Torque limit 1 selection command	16488	Spindle control output 1-8	In torque limit 1 selection
16393	Spindle control input 1-9	Torque limit 2 selection command	16489	Spindle control output 1-9	In torque limit 2 selection
16394	Spindle control input 1-A	Torque limit 3 selection command	16490	Spindle control output 1-A	In torque limit 3 selection
			16492	Spindle control output 1-C	In in-position
			16495	Spindle control output 1-F	In warning
			16496	Spindle control output 2-0	Z phase passed
			16499	Spindle control output 2-3	In zero speed
			16503	Spindle control output 2-7	In external emergency stop
16432	Spindle control input 4-0	Spindle control mode selection command 1	16528	Spindle control output 4-0	In spindle control mode selection 1
16433	Spindle control input 4-1	Spindle control mode selection command 2	16529	Spindle control output 4-1	In spindle control mode selection 2
16434	Spindle control input 4-2	Spindle control mode selection command 3	16530	Spindle control output 4-2	In spindle control mode selection 3
16436	Spindle control input 4-4	Gear changeover command	16532	Spindle control output 4-4	In gear changeover command
16437	Spindle control input 4-5	Gear selection command 1	16533	Spindle control output 4-5	In gear selection 1
16438	Spindle control input 4-6	Gear selection command 2	16534	Spindle control output 4-6	In gear selection 2
			16545	Spindle control output 5-1	Speed detection
16459	Spindle control input 5-B	Minimum excitation rate 2 changeover request	16555	Spindle control output 5-B	In minimum excitation rate 2 selection
16460	Spindle control input 5-C	Speed gain set 2 changeover request	16556	Spindle control output 5-C	In speed gain set 2 selection
16461	Spindle control input 5-D	Zero point re-detection request	16557	Spindle control output 5-D	Zero point re-detection complete
16462	Spindle control input 5-E	Spindle holding force up	16558	Spindle control output 5-E	Spindle holding force up completed
			16559	Spindle control output 5-F	In 2nd in-position

(Note 1) Control signal is bit output. Setting the No. of the table above to the data output(SP125, SP126), and when the scale (SP127, SP128) is set to "0", the output is "0V" for bit 0, and "2.5V" for bit 1.

(Note 2) Refer to the section "Spindle control signal" in Instruction Manual for details on the spindle control signal.

3-6-2 Machine resonance frequency display function

If resonance is generated and it causes vibrations of the current commands, this function estimates the vibration frequency and displays it on the NC monitor screen (AFLT frequency).
This is useful in setting the notch filter frequencies during servo adjustment. This function constantly operates with no need of parameter setting.

3-6-3 Machine inertia display function

With this function, the load current and acceleration rate during motor acceleration are measured to estimate the load inertia.
According to the parameter setting, the estimated load inertia is displayed on the NC monitor screen, expressed as its percentage to the motor inertia.

3-6-4 Motor temperature display function

The temperature sensed by the thermal sensor attached to the motor coil is displayed on the NC screen.

3-6-5 Load monitor output function

A spindle motor's load is output as an analog voltage of 0 to 3V (0 to 120%). To use this function, connect a load meter that meets the specifications.

3-6-6 Open loop control function

This function is to run a spindle motor for operation check before or during the adjustment of the spindle motor's detector. This allows the operation in which no detector feedback signals are used.

4

Characteristics

Contents

4 Characteristics

4-1 Servomotor

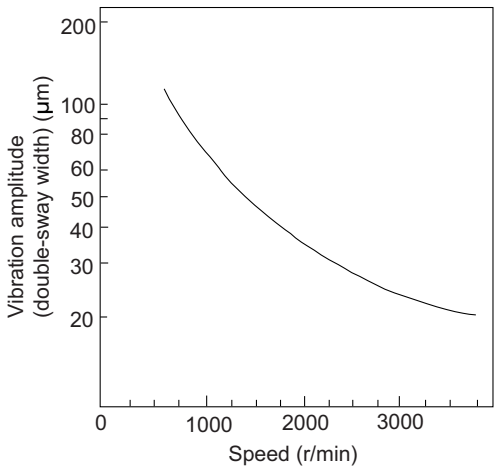
4-1-1 Environmental conditions

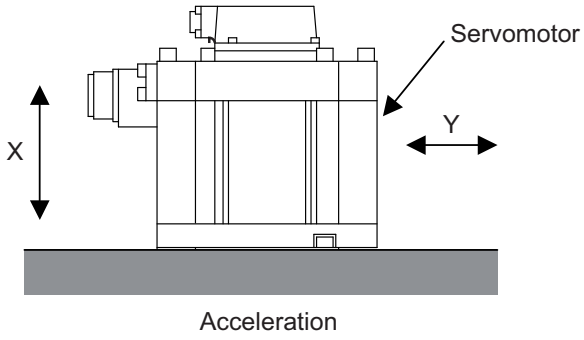
Environment	Conditions
Ambient temperature	0°C to +40°C (with no freezing)
Ambient humidity	80% RH or less (with no dew condensation)
Storage temperature	-15°C to +70°C (with no freezing)
Storage humidity	90% RH or less (with no dew condensation)
Atmosphere	Indoors (no direct sunlight) No corrosive gas, inflammable gas, oil mist or dust
Altitude	Operation / storage: 1000m or less above sea level Transportation: 10000m or less above sea level

4-1-2 Quakeproof level

Motor type	Acceleration direction	
	Axis direction (X)	Direction at right angle to axis (Y)
HF75, 105 **HF54, 104, 154, 224, 123, 223, 142**	24.5m/s^2 (2.5G) or less	24.5m/s^2 (2.5G) or less
HF204, 354, 303, 302	24.5m/s^2 (2.5G) or less	29.4m/s^2 (3G) or less
HF-KP13, 23, 43, 73	49m/s^2 (5G) or less	49m/s^2 (5G) or less

The vibration conditions are as shown below.





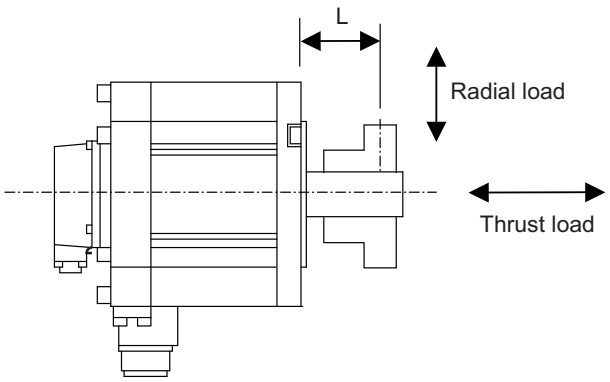
4-1-3 Shaft characteristics

There is a limit to the load that can be applied on the motor shaft. Make sure that the load applied on the radial direction and thrust direction, when mounted on the machine, is below the tolerable values given below. These loads may affect the motor output torque, so consider them when designing the machine.

Servomotor	Tolerable radial load	Tolerable thrust load
HF75T, 105T (Taper shaft)	245N (L=33)	147N
HF75S, 105S (Straight shaft)	245N (L=33)	147N
HF54T, 104T, 154T, 224T,123T, 223T, 142T (Taper shaft)	392N (L=58)	490N
HF54S, 104S, 154S, 224S,123S, 223S, 142S (Straight shaft)	980N (L=55)	490N
HF204S, 354S, 303S, 302S (Straight shaft)	2058N (L=79)	980N
HF-KP13 (Straight shaft)	88N (L=25)	59N
HF-KP23, 43 (Straight shaft)	245N (L=30)	98N
HF-KP73 (Straight shaft)	392N (L=40)	147N

(Note 1) The tolerable radial load and thrust load in the above table are values applied when each motor is used independently.

(Note 2) The symbol L in the table refers to the value of L below.



L: Length from flange installation surface to center of load mass [mm]

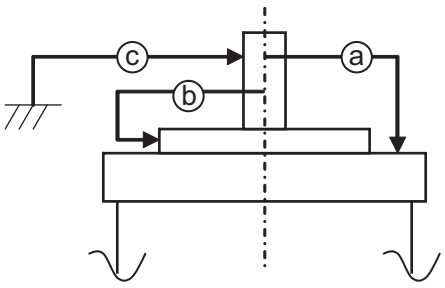
CAUTION !

1. Use a flexible coupling when connecting with a ball screw, etc., and keep the shaft core deviation to below the tolerable radial load of the shaft.
2. When directly installing the gear on the motor shaft, the radial load increases as the diameter of the gear decreases. This should be carefully considered when designing the machine.
3. When directly installing the pulley on the motor shaft, carefully consider so that the radial load (double the tension) generated from the timing belt tension is less than the values shown in the table above.
4. In machines where thrust loads such as a worm gear are applied, carefully consider providing separate bearings, etc., on the machine side so that loads exceeding the tolerable thrust loads are not applied to the motor.

4-1-4 Machine accuracy

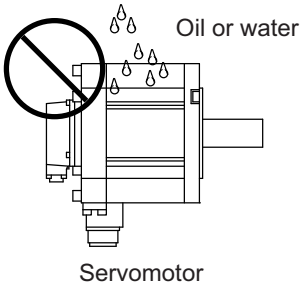
Machine accuracy of the servo motor's output shaft and around the installation part is as below.
(Excluding special products)

Accuracy (mm)	Measurement point	Flange size [mm]			
		Less than 100	100 SQ., 130 SQ.	176 SQ. - 250 SQ.	280 or over
Amplitude of the flange surface to the output shaft	a	0.05	0.06	0.08	0.08
Amplitude of the flange surface's fitting outer diameter	b	0.04	0.04	0.06	0.08
Amplitude of the output shaft end	c	0.02	0.02	0.03	0.03



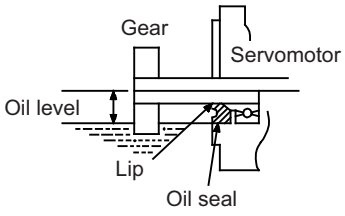
4-1-5 Oil / water standards

(1) The motor protective format uses the IP type, which complies with IEC Standard. (Refer to the section “2-1-1 Specifications list".) However, these Standards are short-term performance specifications. They do not guarantee continuous environmental protection characteristics. Measures such as covers, etc., must be taken if there is any possibility that oil or water will fall on the motor, and the motor will be constantly wet and permeated by water. Note that the motor's IP-type is not indicated as corrosion-resistant.

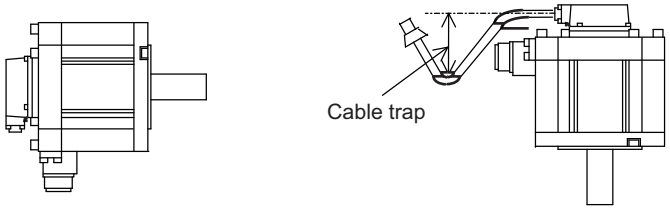


(2) When a gear box is installed on the servomotor, make sure that the oil level height from the center of the shaft is higher than the values given below. Open a breathing hole on the gear box so that the inner pressure does not rise.

Servomotor	Oil level (mm)
HF75, 105	15
HF54, 104, 154, 224, 123, 223, 142	22.5
HF204, 354, 303, 302	30
HF-KP13	9.5
HF-KP23, 43	12.5
HF-KP73	15



(3) When installing the servomotor horizontally, set the power cable and detector cable to face downward. When installing vertically or on an inclination, provide a cable trap.



CAUTION !

1. The servomotors, including those having IP67 specifications, do not have a completely waterproof (oil-proof) structure. Do not allow oil or water to constantly contact the motor, enter the motor, or accumulate on the motor. Oil can also enter the motor through cutting chip accumulation, so be careful of this also.
2. When the motor is installed facing upwards, take measures on the machine side so that gear oil, etc., does not flow onto the motor shaft.

4-1-6 Flange of servo motor

Mount the servo motor on a flange which has the following size or produces an equivalent or higher heat dissipation effect:

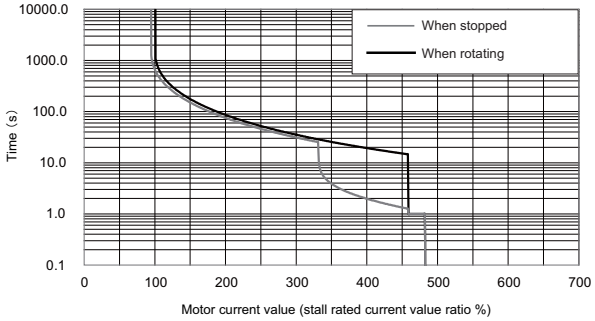
Flange size (mm)	Servo Motor HF, HF-KP
150x150x6	50 to 100W
250x250x6	200 to 400W
250x250x12	0.5 to 1.5kW
300x300x20	2.0 to 7.0kW
800x800x35	9.0 to 11.0kW

4-1-7 Overload protection characteristics

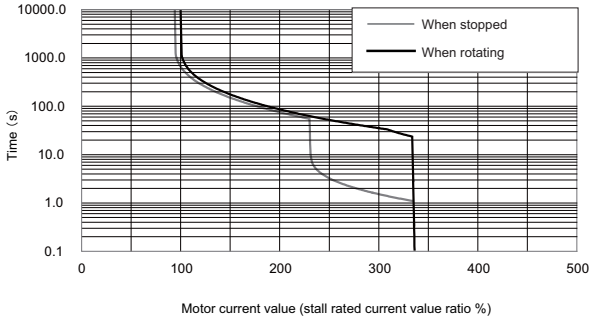
The servo drive unit has an electronic thermal relay to protect the servomotor and servo drive unit from overloads. The operation characteristics of the electronic thermal relay are shown below when standard parameters (SV021=60, SV022=150) are set. If overload operation over the electronic thermal relay protection curve shown below is carried out, overload 1 (alarm 50) will occur. If the maximum torque is commanded continuously for one second or more due to a machine collision, etc., overload 2 (alarm 51) will occur.

< HF series >

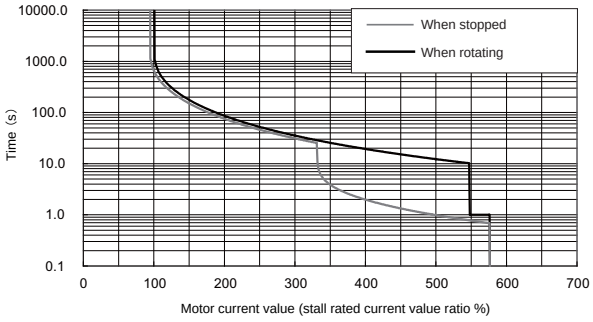
HF75



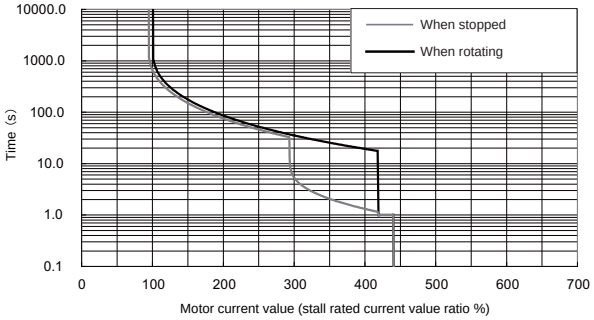
HF105



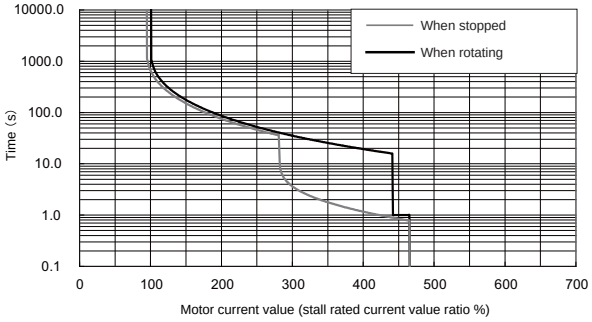
HF54



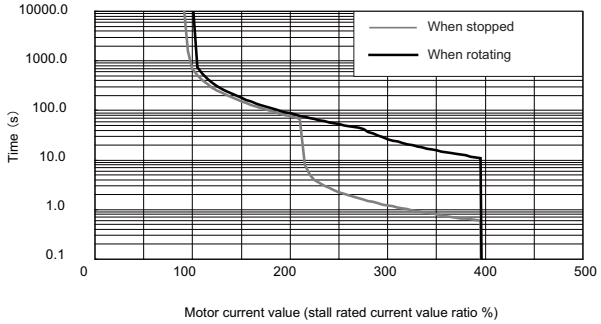
HF104



HF154



HF224



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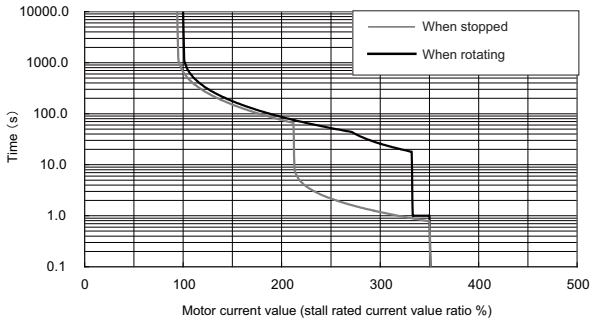

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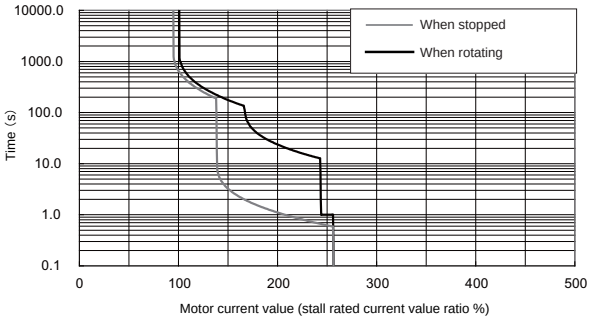

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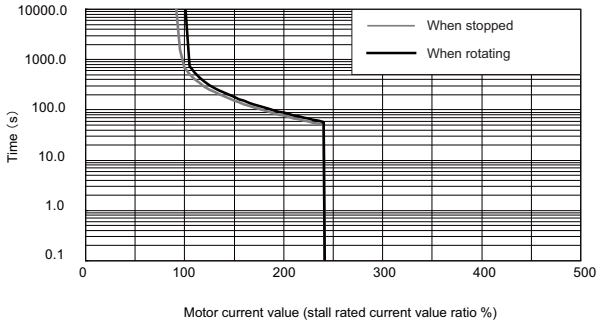

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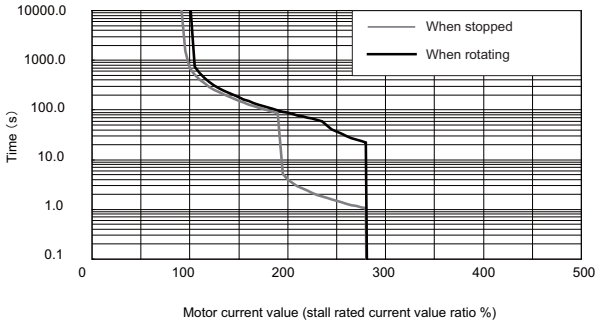
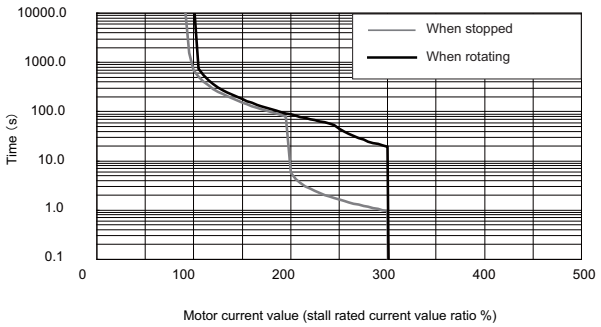


4 Characteristics

HF303



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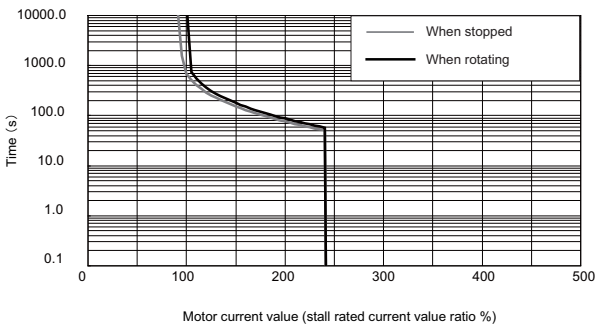

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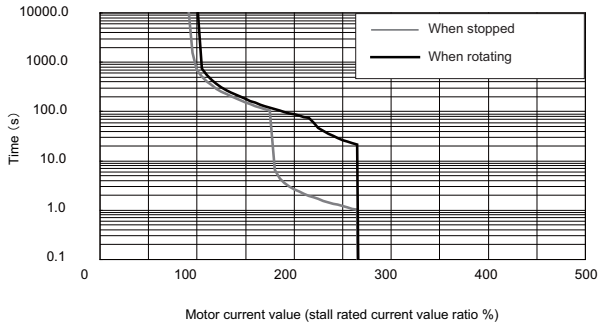
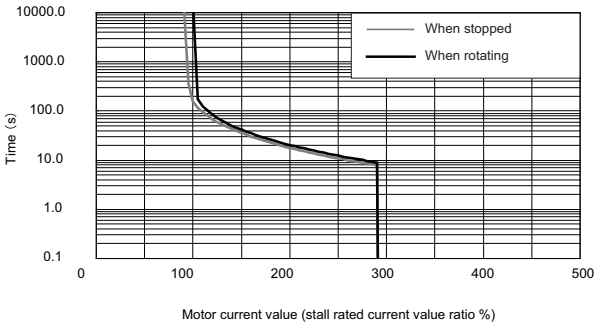


< HF-KP series >

HF-KP13



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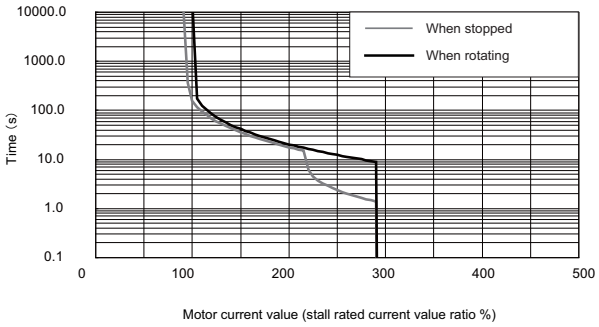

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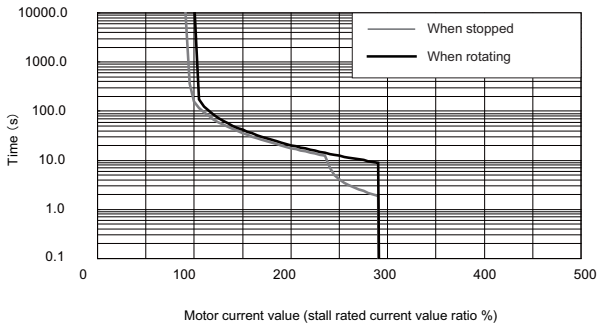
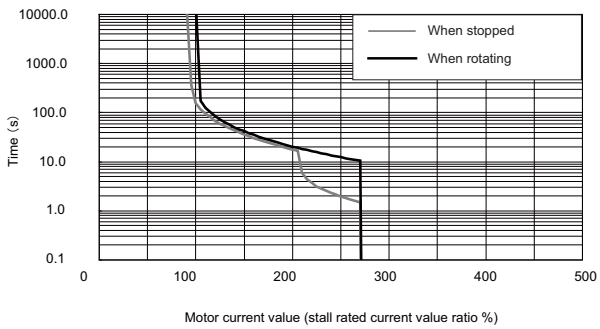


HF-KP73



4-1-8 Magnetic brake

CAUTION !

1. The axis will not be mechanically held even when the dynamic brakes are used. If the machine could drop when the power fails, use a servomotor with magnetic brakes or provide an external brake mechanism as holding means to prevent dropping.
2. The magnetic brakes are used for holding, and must not be used for normal braking. There may be cases when holding is not possible due to the life or machine structure (when ball screw and servomotor are coupled with a timing belt, etc.). Provide a stop device on the machine side to ensure safety.
3. When operating the brakes, always turn the servo OFF (or ready OFF). When releasing the brakes, always confirm that the servo is ON first. Sequence control considering this condition is possible by using the brake contact connection terminal on the servo drive unit.
4. When the vertical axis drop prevention function is used, the drop of the vertical axis during an emergency stop can be suppressed to the minimum.

(1) Motor with magnetic brake

(a) Types

The motor with a magnetic brake is set for each motor. The "B" following the standard motor model stands for the motor with a brake.

(b) Applications

When this type of motor is used for the vertical feed axis in a machining center, etc., slipping and dropping of the spindle head can be prevented even when the hydraulic balancer's hydraulic pressure reaches zero when the power turns OFF. When used with a robot, deviation of the posture when the power is turned OFF can be prevented.

When used for the feed axis of a grinding machine, a double safety measures is formed with the deceleration stop (dynamic brake stop) during emergency stop, and the risks of colliding with the grinding stone and scattering can be prevented.

This motor cannot be used for the purposes other than holding and braking during a power failure (emergency stop). (This cannot be used for normal deceleration, etc.)

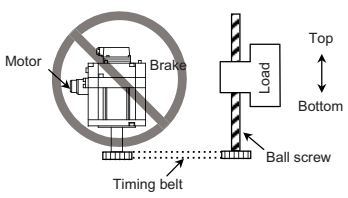
(c) Features

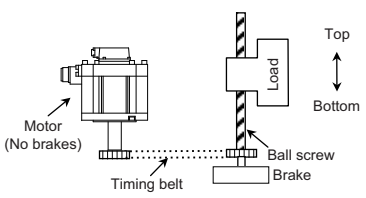
[1] The magnetic brakes use a DC excitation method, thus:
- The brake mechanism is simple and the reliability is high.
- There is no need to change the brake tap between 50Hz and 60Hz.
- There is no rush current when the excitation occurs, and shock does not occur.
- The brake section is not larger than the motor section.

[2] The magnetic brake is built into the motor, and the installation dimensions are the same as the motor without brake.

(d) Cautions for using a timing belt

Connecting the motor with magnetic brakes and the load (ball screw, etc.) with a timing belt as shown on the left below could pose a hazard if the belt snaps. Even if the belt's safety coefficient is increased, the belt could snap if the tension is too high or if cutting chips get imbedded. Safety can be maintained by using the method shown on the right below.





(2) Magnetic brake characteristics

< HF Series >

Item		Motor type		
		HF75B, HF105B	HF54B, HF104B HF154B,HF224B HF123B, HF223B HF142B	HF204B, HF354B HF303B, HF302B
Type (Note 1)		Spring closed non-exciting operation magnetic brakes (for maintenance and emergency braking)		
Rated voltage		24VDC		
Rated current at 20°C (A)		0.38	0.8	1.4
Capacity (W)		9	19	34
Static friction torque (N•m)		2.4	8.3	43.1
Inertia (Note 2) (kg•cm^2)		0.2	2.2	9.7
Release delay time (Note 3) (s)		0.03	0.04	0.1
Braking delay time (DC OFF) (Note 3) (s)		0.03	0.03	0.03
Tolerable braking work amount	Per braking (J)	64	400	4,500
	Per hour (J)	640	4,000	45,000
Brake play at motor axis (degree)		0.1 to 0.9	0.2 to 0.6	0.2 to 0.6
Brake life (Note 4)	No. of braking operations (times)	20,000	20,000	20,000
	Work amount per braking (J)	32	200	1,000

< HF-KP Series >

Item		Motor type		
		HF-KP13B	HF-KP23B, HF-KP43B	HF-KP73B
Type (Note 1)		Spring closed non-exciting operation magnetic brakes (for maintenance and emergency braking)		
Rated voltage		24VDC		
Rated current at 20°C(A)		0.26	0.33	0.42
Capacity (W)		6.3	7.9	10
Static friction torque (N•m)		0.32	1.3	2.4
Inertia (Note 2) (kg•cm^2)		0.002	0.08	0.2
Release delay time (Note3) (s)		0.03	0.03	0.04
Braking delay time (DC OFF) (Note3) (s)		0.01	0.02	0.02
Tolerable braking work amount	Per braking (J)	5.6	22	64
	Per hour (J)	56	220	640
Brake play at motor axis (degree)		2.5	1.2	0.9
Brake life (Note4)	No. of braking operations (times)	20,000	20,000	20,000
	Work amount per braking (J)	5.6	22	64

(Note 1) There is no manual release mechanism. If handling is required such as during the machine core alignment work, prepare a separate 24VDC power supply, and electrically release a brake.
(Note 2) These are the values added to the servomotor without a brake.
(Note 3) This is the representative value for the initial attraction gap at 20°C.
(Note 4) The brake gap will widen through brake lining wear caused by braking. However, the gap cannot be adjusted. Thus, the brake life is considered to be reached when adjustments are required.
(Note 5) A leakage flux will be generated at the shaft end of the servomotor with a magnetic brake.
(Note 6) When operating in low speed regions, the sound of loose brake lining may be heard. However, this is not a problem in terms of function.

(3) Magnetic brake power supply

CAUTION !

1. Always install a surge absorber on the brake terminal when using DC OFF.
2. Do not pull out the cannon plug while the brake power is ON. The cannon plug pins could be damaged by sparks.

(a) Brake excitation power supply

[1] Prepare a brake excitation power supply that can accurately ensure the attraction current in consideration of the voltage fluctuation and excitation coil temperature.

[2] The brake terminal polarity is random. Make sure not to mistake the terminals with other circuits.

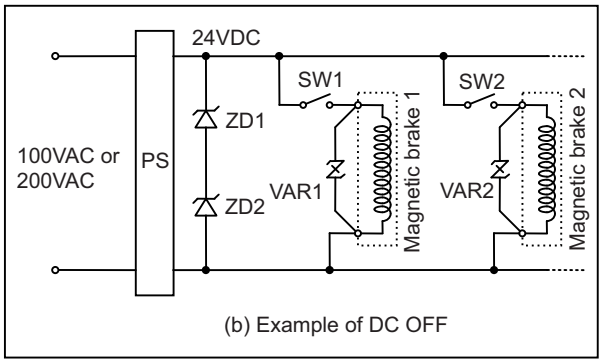
(b) Bake excitation circuit

When turning OFF the brake excitation power supply (to apply the brake), DC OFF is used to shorten the braking delay time.

A surge absorber will be required. Pay attention to the relay cut off capacity.

<Cautions>

- Provide sufficient DC cut off capacity at the contact.
- Always use a surge absorber.
- When using the cannon plug type, the surge absorber will be further away, so use shielded wires between the motor and surge absorber.



PS : 24VDC stabilized power supply
ZD1,ZD2 : Zener diode for power supply protection (1W, 24V)
VAR1,VAR2 : Surge absorber

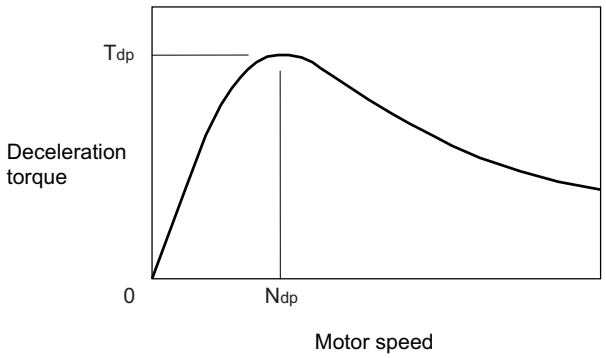
Magnetic brake circuits

4-1-9 Dynamic brake characteristics

If a servo alarm that cannot control the motor occurs, the dynamic brakes will function to stop the servomotor regardless of the parameter settings.

(1) Deceleration torque

The dynamic brake uses the motor as a generator, and obtains the deceleration torque by consuming that energy with the dynamic brake resistance. The characteristics of this deceleration torque have a maximum deceleration torque (Tdp) regarding the motor speed as shown in the following drawing. The torque for each motor is shown in the following table.



Deceleration torque characteristics of a dynamic brake

Max. deceleration torque of a dynamic brake

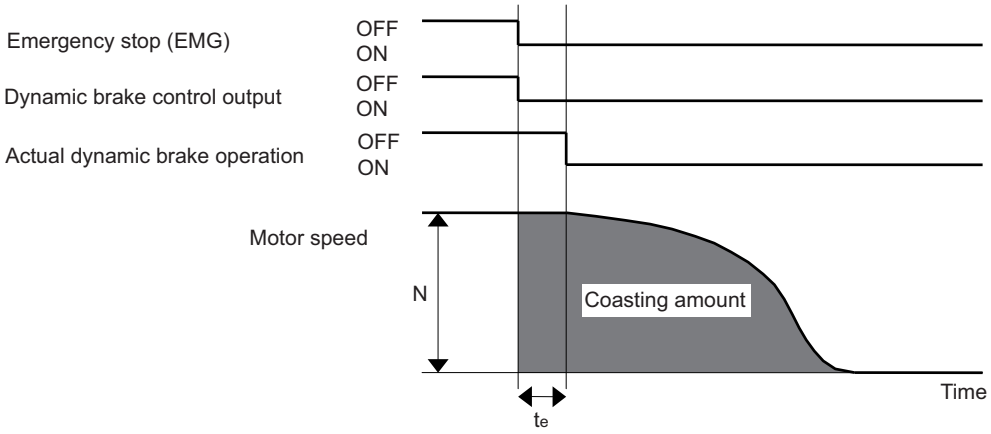
Motor type	Stall torque (N•m)	Tdp (N•m)	Ndp (r/min)
HF75	2.0	2.71	4120
HF105	3.0	5.10	5544
HF54	2.9	1.98	1886
HF104	5.9	10.02	735
HF154	9.0	15.65	850
HF224	12.0	20.06	1042
HF204	13.7	15.97	617
HF354	22.5	35.28	908
HF123	7.0	9.79	561
HF223	12.0	19.95	686
HF303	22.5	30.43	550
HF142	11.0	14.43	427
HF302	20.0	29.42	396
HF-KP13	0.32	0.22	1522
HF-KP23	0.64	0.52	1062
HF-KP43	1.3	1.30	822
HF-KP73	2.4	1.48	3449

(2) Coasting rotation distance during emergency stop

The distance that the motor coasts (angle for rotary axis) when stopping with the dynamic brakes can be approximated with the following expression.

$$L_{MAX} = \frac{F}{60} \cdot \{ t_e + (1 + \frac{J_L}{J_M}) \cdot (A \cdot N^2 + B) \}$$

L_{MAX}	: Motor coasting distance (angle)	[mm, (deg)]
F	: Axis feedrate	[mm/min, (deg/min)]
N	: Motor speed	[r/min]
J_M	: Motor inertia	[kg•cm^2]
J_L	: Motor shaft conversion load inertia	[kg•cm^2]
t_e	: Brake drive relay delay time	[s] (Normally, 0.03s)
A	: Coefficient A (Refer to the next page)	
B	: Coefficient B (Refer to the next page)	



Dynamic brake braking diagram

Coasting amount calculation coefficients table

Motor type	JM (kg•cm^2)	A	B
HF75	2.6	0.41×10^{-9}	20.66×10^{-3}
HF105	5.1	0.31×10^{-9}	29.01×10^{-3}
HF54	6.1	2.85×10^{-9}	30.40×10^{-3}
HF104	11.9	2.82×10^{-9}	4.57×10^{-3}
HF154	17.8	2.34×10^{-9}	5.06×10^{-3}
HF224	23.7	1.98×10^{-9}	6.44×10^{-3}
HF204	38.3	6.78×10^{-9}	7.75×10^{-3}
HF354	75.0	4.09×10^{-9}	10.11×10^{-3}
HF123	11.9	3.78×10^{-9}	3.57×10^{-3}
HF223	23.7	3.02×10^{-9}	4.27×10^{-3}
HF303	75.0	7.82×10^{-9}	7.10×10^{-3}
HF142	17.8	5.04×10^{-9}	2.76×10^{-3}
HF302	75.0	11.23×10^{-9}	5.29×10^{-3}
HF-KP13	0.88	0.25×10^{-9}	3.12×10^{-3}
HF-KP23	0.23	0.41×10^{-9}	2.47×10^{-3}
HF-KP43	0.42	0.39×10^{-9}	1.39×10^{-3}
HF-KP73	1.43	0.27×10^{-9}	17.43×10^{-3}

4-2 Spindle motor

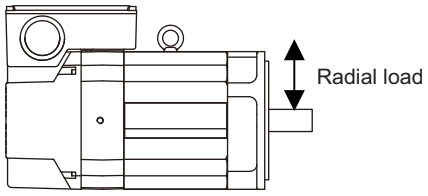
4-2-1 Environmental conditions

Environment	Conditions
Ambient temperature	0°C to +40°C (with no freezing)
Ambient humidity	90% RH or less (with no dew condensation)
Storage temperature	-20°C to +65°C(with no freezing)
Storage humidity	90% RH or less (with no dew condensation)
Atmosphere	Indoors (no direct sunlight); no corrosive gas, inflammable gas, oil mist or dust
Altitude	Operation/storage: 1000m or less above sea level Transportation: 10000m or less above sea level

4-2-2 Shaft characteristics

There is a limit to the load that can be applied on the motor shaft. Make sure that the load applied on the radial direction, when mounted on the machine, is below the tolerable values given below. These loads may affect the motor output torque, so consider them when designing the machine.

Spindle motor	Tolerable radial load
SJ-VL2.2ZT	196N
SJ-VL11-10FZT	245N
SJ-VL0.75-01T, SJ-VL1.5-01T	490N
SJ-D3.7/100-01, SJ-DJ5.5/100-01 SJ-V2.2-01T, SJ-V3.7-01T, SJ-V5.5-01ZT, SJ-V7.5-01ZT, SJ-V7.5-03ZT, SJ-VL11-05FZT-S01, SJ-VL11-07ZT,	980N
SJ-D5.5/100-01, SJ-DJ7.5/100-01	1470N
SJ-D7.5/100-01, SJ-D11/80-01, SJ-DJ11/100-01 SJ-V11-01ZT	1960N



(Note) The load point is at the one-half of the shaft length.

⚠ CAUTION Consider on the machine side so that the thrust loads are not applied to the spindle motor.

4-3 Tool spindle motor

4-3-1 Environmental conditions

Environment	Conditions
Ambient temperature	0°C to +40°C (with no freezing)
Ambient humidity	80% RH or less (with no dew condensation)
Storage temperature	-15°C to +70°C (with no freezing)
Storage humidity	90% RH or less (with no dew condensation)
Atmosphere	Indoors (no direct sunlight) No corrosive gas, inflammable gas, oil mist or dust
Altitude	Operation / storage: 1000m or less above sea level Transportation: 10000m or less above sea level

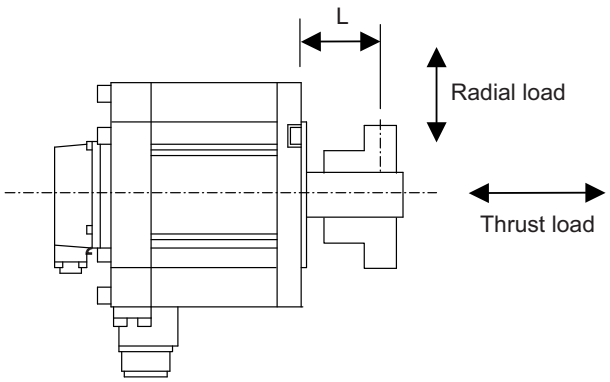
4-3-2 Shaft characteristics

There is a limit to the load that can be applied on the motor shaft. Make sure that the load applied on the radial direction and thrust direction, when mounted on the machine, is below the tolerable values given below. These loads may affect the motor output torque, so consider them when designing the machine.

Tool spindle motor	Tolerable radial load	Tolerable thrust load
HF-KP46, 56	245N (L=30)	98N
HF-KP96	392N (L=40)	147N
HF75S, 105S	245N (L=33)	147N
HF54S, 104S, 154S, 224S, 123S, 223S	980N (L=55)	490N
HF204S, 303S	2058N (L=79)	980N

(Note 1) The tolerable radial load and thrust load in the above table are values applied when each motor is used independently.

(Note 2) The symbol L in the table refers to the value of L below.

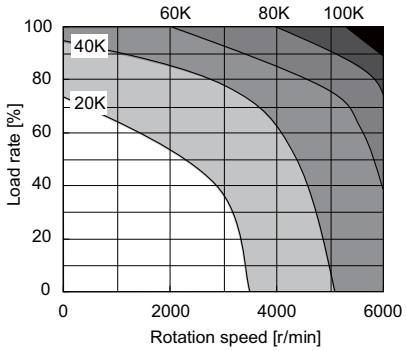


L: Length from flange installation surface to center of load mass [mm]

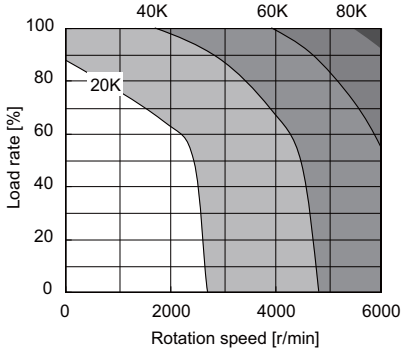
4-3-3 Tool spindle temperature characteristics

< HF-KP Series >

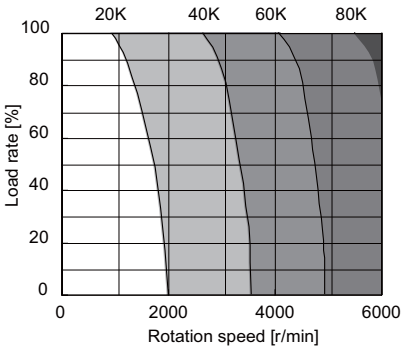
[HF-KP46J(K)W09]



[HF-KP56J(K)W09]



[HF-KP96J(K)W09]



(Note1) The contour lines 20K to 100K in the graph indicate the temperature rising values from the start-up to saturation.

(Note2) The motor temperature tends to rise in a high-speed rotation even if the load rate is low.

4-4 Drive unit

4-4-1 Environmental conditions

Environment	Conditions
Ambient temperature	0°C to +55°C (with no freezing)
Ambient humidity	90% RH or less (with no dew condensation)
Storage temperature	-15°C to +70°C (with no freezing)
Storage humidity	90% RH or less (with no dew condensation)
Atmosphere	Indoors (no direct sunlight); no corrosive gas, inflammable gas, oil mist, dust or conductive fine particles
Altitude	Operation/storage: 1000m or less above sea level Transportation: 13000m or less above sea level
Vibration	Operation/storage: 4.9m/s^2 (0.5G) or less Transportation: 49m/s^2(5G) or less

(Note) When installing the machine at 1,000m or more above sea level, the heat dissipation characteristics will drop as the altitude increases. The upper limit of the ambient temperature drops 1°C with every 100m increase in altitude. (The ambient temperature at an altitude of 2,000m is between 0 and 45°C.)

4-4-2 Heating value

Each heating value is calculated with the following values.
The values for the servo drive unit apply at the stall output. The values for the spindle drive unit apply for the continuous rated output.

Servo drive unit		Spindle drive unit	
Type MDS-D-SVJ3-	Heating value [W] Inside panel	Type MDS-D-SVJ3-	Heating value [W] Inside panel
03NA	25	**075NA**	50
04NA	35	**22NA**	90
07NA	50	**37NA**	130
10NA	90	**55NA**	150
20NA	130	**75NA**	200
35NA	195	**110NA**	300

POINT

1. Design the panel's heating value taking the actual axis operation (load rate) into consideration.

2.The heating values in the above tables are calculated with the following load rates.

Unit	Load rate
Servo drive unit	50%
Spindle drive unit	100%

5

Dedicated Options

Contents

5 Dedicated Options

5-1 Servo options

The option units are required depending on the servo system configuration. Check the option units to be required referring the following items.

(1) System establishment in the full closed loop control

Refer to the table below to confirm the interface unit (I/F) and battery option required for the full closed loop control.

(a) Full closed loop control for linear axis

Machine side detector to be used			Detector signal output	Interface unit	Drive unit input signal	Battery option	Remarks
Incre-mental detector	Rectangular wave signal output	SR74, SR84 (MAGNESCALE)	Rectangular wave signal	-	Rectangular wave signal	-	
		Various scale	Rectangular wave signal	-	Rectangular wave signal	-	
	SIN wave signal out-put	LS187, LS487 (HEIDENHAIN)	SIN wave signal	IBV series (HEIDENHAIN)	Rectangular wave signal	-	
				EIB series (HEIDENHAIN)	Mitsubishi serial signal	-	
		Various scale	SIN wave signal	MDS-B-HR-11(P) (MITSUBISHI ELECTRIC)	Mitsubishi serial signal	(Required) Note	Distance-coded reference scale is also available
	Mitsubishi serial signal output	SR75, SR85 (MAGNESCALE)	Mitsubishi serial signal	-	Mitsubishi serial signal	-	
Abso-lute position detector	Mitsubishi serial signal output	OSA105-ET2 (MITSUBISHI)	Mitsubishi serial signal	-	Mitsubishi serial signal	Required	Ball screw end detector
		SR77, SR87 (MAGNESCALE)	Mitsubishi serial signal	-	Mitsubishi serial signal	Not required	
		LC193M, LC493M (HEIDENHAIN)	Mitsubishi serial signal	-	Mitsubishi serial signal	Not required	
		AT343, AT543, AT545 (Mitutoyo)	Mitsubishi serial signal	-	Mitsubishi serial signal	Not required	
		SAM Series (FAGOR)	Mitsubishi serial signal	-	Mitsubishi serial signal	Not required	
		SVAM Series (FAGOR)	Mitsubishi serial signal	-	Mitsubishi serial signal	Not required	
		GAM Series (FAGOR)	Mitsubishi serial signal	-	Mitsubishi serial signal	Not required	
		LAM Series (FAGOR)	Mitsubishi serial signal	-	Mitsubishi serial signal	Not required	
	SIN wave signal out-put	MPS Series (MME Corp.)	SIN wave signal	ADB-20J60 (MME Corp.)	Mitsubishi serial signal	Required	

(Note) When using the distance-coded reference scale, it is recommended to use with distance-coded reference check function. In this case, the battery option is required.

(b) Full closed loop control for rotary axis

Machine side detector to be used			Detector signal output	Interface unit	Output signal	Battery option	Remarks
Incre-mental detector	Rectangular wave signal output	Various scale	Rectangular wave signal	-	Rectangular wave signal	-	
	SIN wave signal output	ERM280 Series (HEIDENHAIN)	SIN wave signal	EIB series (HEIDENHAIN)	Mitsubishi serial signal	-	
		Various scale	SIN wave signal	MDS-B-HR-11(P) (MITSUBISHI ELECTRIC)	Mitsubishi serial signal	-	
Abso-lute position detector	Mitsubishi serial signal output	RU77 (MAGNESCALE)	Mitsubishi serial signal	-	Mitsubishi serial signal	Not required	
		RCN223M, RCN227M (HEIDENHAIN)	Mitsubishi serial signal	-	Mitsubishi serial signal	Not required	
		RCN727M, RCN827M (HEIDENHAIN)	Mitsubishi serial signal	-	Mitsubishi serial signal	Not required	
	SIN wave signal output	MPRZ Series (MME Corp.)	SIN wave signal	ADB-20J71 (MME Corp.)	Mitsubishi serial signal	Not required	
		MPI Series (MME Corp.)	SIN wave signal	ADB-20J60 (MME Corp.)	Mitsubishi serial signal	Required	

<Contact information about machine side detector>

- Magnescale Co., Ltd: http://www.mgscale.com/mgs/
- HEIDENHAIN CORPORATION: http://www.heidenhain.de/
- Mitutoyo Corporation: http://www.mitutoyo.co.jp/
- MHI MACHINE TOOL ENGINEERING CO., LTD: http://www.mme-e.co.jp/
- FAGOR Automation: http://www.fagorautomation.com/

POINT

The absolute position system cannot be established in combination with the relative position (incremental) machine side detector and absolute position motor side detector.

(2) System establishment in the synchronous control

(a) Position command synchronous control

The synchronous control is all executed in the NC, and the each servo is controlled as an independent axis. Therefore, preparing special options for the synchronous control is not required on the servo side.

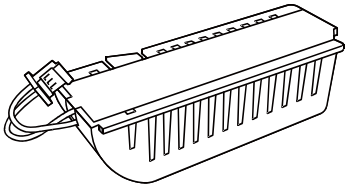
POINT

When executing the synchronous control, use the servomotors of which the type and detector specifications are same.

5 Dedicated Options

5-1-1 Battery option

This battery option may be required to establish absolute position system. Refer to "Servo option" and use the following battery option depending on the servo system.

Type	MR-J3BAT	MDS-BTBOX-36
Installation type	Drive unit with battery holder type	Unit and battery integration type
Hazard class	Not applicable	Not applicable
Number of connectable axes	1 axis	Up to 8 axes
Battery change	Possible	Possible
Appearance	(1) 	(2) 

⚠ CAUTION

1. On January 1, 2003, new United Nations requirements, "United Nations Dangerous Goods Regulations Article 12", became effective regarding the transportation of lithium batteries. The lithium batteries are classified as hazardous materials (Class 9) depending on the unit. (Refer to Appendix 2.)
2. The lithium battery must be transported according to the rules set forth by the International Civil Aviation Organization (ICAO), International Air Transportation Association (IATA), International Maritime Organization (IMO), and United States Department of Transportation (DOT), etc. The packaging methods, correct transportation methods, and special regulations are specified according to the quantity of lithium alloys. The battery unit exported from Mitsubishi is packaged in a container (UN approved part) satisfying the standards set forth in this UN Advisory.
3. To protect the absolute value, do not shut off the servo drive unit control power supply if the battery voltage becomes low (warning 9F).
4. Contact the Service Center when replacing the battery.
5. The battery life (backup time) is greatly affected by the working ambient temperature. The above data is the theoretical value for when the battery is used 8 hours a day/240 days a year at an ambient temperature of 25°C. Generally, if the ambient temperature increases, the backup time and useful life will both decrease.

(1) Cell battery (MR-J3BAT)

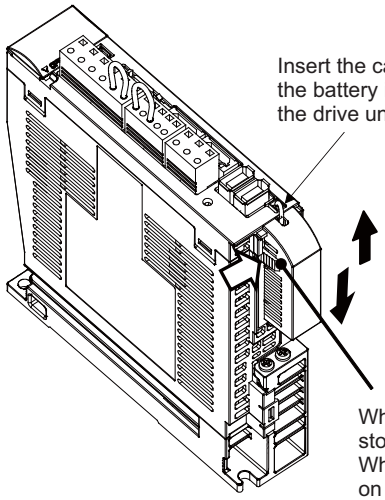
(a) Specifications

Battery option type		Cell battery
		MR-J3BAT(Note1)
Lithium battery series		ER6V
Nominal voltage		3.6V
Nominal capacity		2000mAh
Battery safety	Hazard class	-
	Battery shape	Single battery
	Number of batteries used	ER6V×1
	Lithium alloy content	0.7g
	Mercury content	1g or less
Number of connectable axes		1 axis
Battery continuous backup time		Approx. 20000 hours
Battery useful life (From date of unit manufacture)		7 years
Data save time in battery replacement		HF series: approx. 20 hours at time of delivery, approx. 10 hours after 5 years
Back up time from battery warning to alarm occurrence (Note2)		Approx. 100 hours
Mass		20g

(Note1) MR-J3BAT is a battery built in a servo drive unit. Install this battery only in the servo drive unit that executes absolute position control.

(Note2) This time is a guideline, so does not guarantee the back up time. Replace the battery with a new battery as soon as a battery alarm occurs.

(b) Installing the cell battery



(2) Battery box (MDS-BTBOX-36)

⚠CAUTION MDS-D-SVJ3 Series have no battery voltage drop warning signal input.
To use MDS-BTBOX-36, be sure to use together with MDS-D/DH/DM Series.

(a) Specifications

Battery option type	Battery box
	MDS-BTBOX-36
Battery model name	size-D alkaline batteries LR20 x 4 pieces (Note1)
Nominal voltage	3.6V (Unit output), 1.5V (Isolated battery)
Number of connectable axes	Up to 8 axes
Battery continuous backup time	Approx. 10000 hours (when 8 axes are connected, cumulative time in non-energized state) (Note2)
Back up time from battery warning to alarm occurrence	Approx. 336 hours (when 8 axes are connected) (Note2)

(Note 1) Install commercially-available alkaline dry batteries into MDS-BTBOX-36. The batteries should be procured by customers.

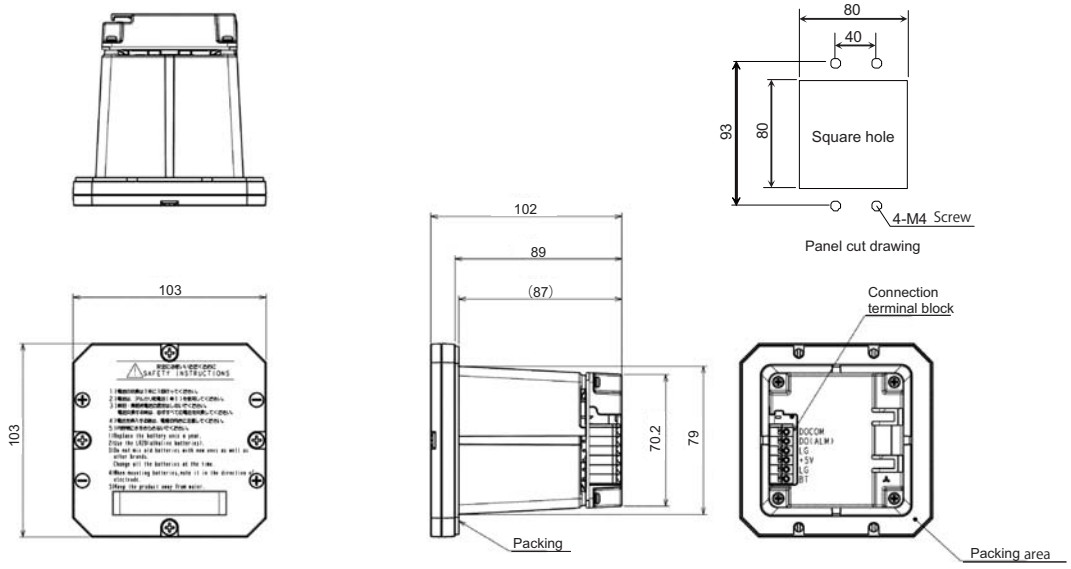
(Note 2) These backup periods are estimated based on the JIS standard, assuming that the product is used at a room temperature. The actual backup period may vary depending on the batteries (type and storage period after production, etc.) and the operating environment. Thus, regard these values only as a guide.

(b) Outline dimension drawings

		Name	Description
(1)	Power supply output for absolute position detector backup	BT	3.6V output for absolute position detector backup
(2)		LG	Ground
(3)	Power supply input for battery voltage drop detection circuit	+5V	5V power supply input for battery voltage drop detection circuit
(4)		LG	Ground
(5)	Battery voltage drop warning signal output	DO(ALM)	Battery voltage drop warning output
(6)		DOCOM	DO output common

(c) Outline dimension drawings

[Unit: mm]



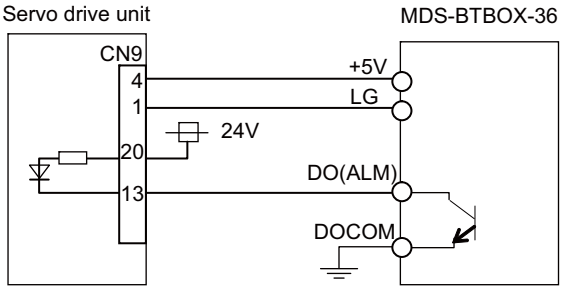
POINT As soon as the battery warning has occurred, replace the batteries with new ones.
Make sure to use new batteries that have not passed the expiration date. We recommend you to replace the batteries in the one-year cycle.

(d) Wiring of the battery voltage drop warning output

The battery voltage drop warning is detected in the MDS-BTBOX-36 and output to the servo drive unit as digital signal.Connect the battery voltage drop warning signal to one of the servo drive units supported by MDS-BTBOX-36. For the connected servo axis, set the servo parameter "SV082/bitF-C" to "2" to enable this signal input. When using 2 or 3-axis drive unit, set the value to one of the axes and set other axes in the same unit to "0" (No signal).

(e) When backing up for more than 8 axes

Add a MDS-BTBOX-36 so that the number of connectable axes for a battery unit is 8 axes or less. For all of servo drive units supported by one MDS-BTBOX-36, start the control powers ON simultaneously.



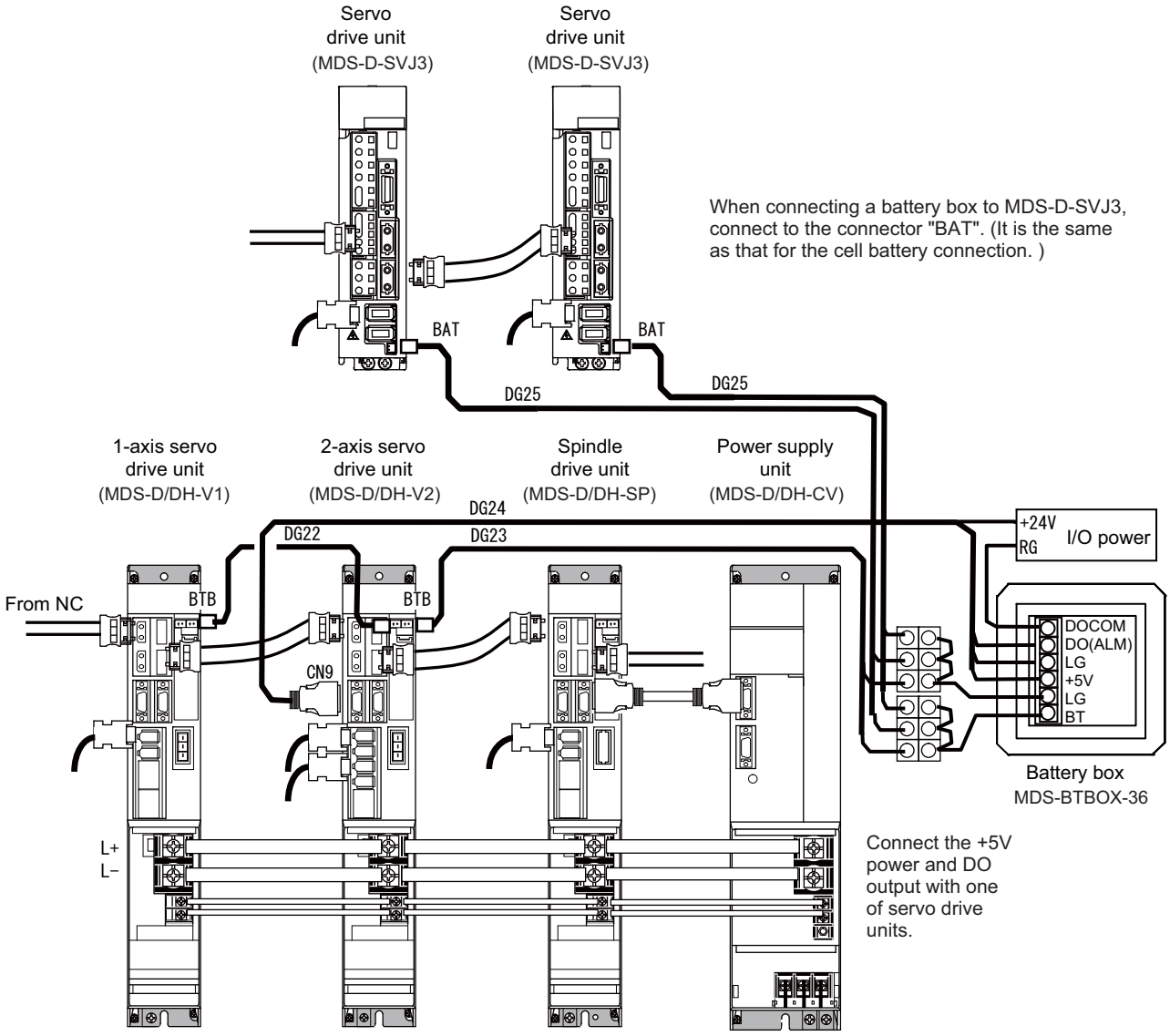
Battery voltage drop warning signal connection diagram

⚠ CAUTION

1. The battery voltage drop warning signal and safety observation function door state signal cannot be connected to the same drive unit. To use these function together as a system, connect to the different drive unit.
2. Battery voltage drop warning (9F) can also occur when the cable between the battery box and drive unit is broken.
3. For 2-axis or 3-axis drive unit, the parameter error "E4" or drivers communication error "82" occurs at all the axes when the setting of SV082(SSF5)/bitF-C differs according to axes (except 0 setting).
4. The drive unit which is connected to the battery box and cell battery cannot be used together.
5. Replace the batteries with new ones without turning the control power of the drive unit OFF immediately after the battery voltage drop alarm (9F) has been detected.
6. Replace the batteries while applying the control power of all drive units which are connected to the battery box.
7. When changing the wiring of the CN9 control input, change after SV082(SSF5)/bitF-C is set to 0. Otherwise unexpected alarms can be detected because of a mismatch of the control input signal and setting parameter.

5 Dedicated Options

System configuration



⚠ CAUTION

1. MDS-D-SVJ3 Series have no battery voltage drop warning signal input. Connect to CN9 of MDS-D/DH/DM Series servo drive unit.
2. 24V power for DO output must always be turned ON before the NC power input.
3. Spindle drive unit has no battery voltage drop warning function. Wiring to CN9 of drive unit must be always connected to servo drive unit.
4. The total length of battery cable (from the battery unit to the last connected drive unit) must be 3m or less.

5-1-2 Ball screw side detector (OSA105-ET2)

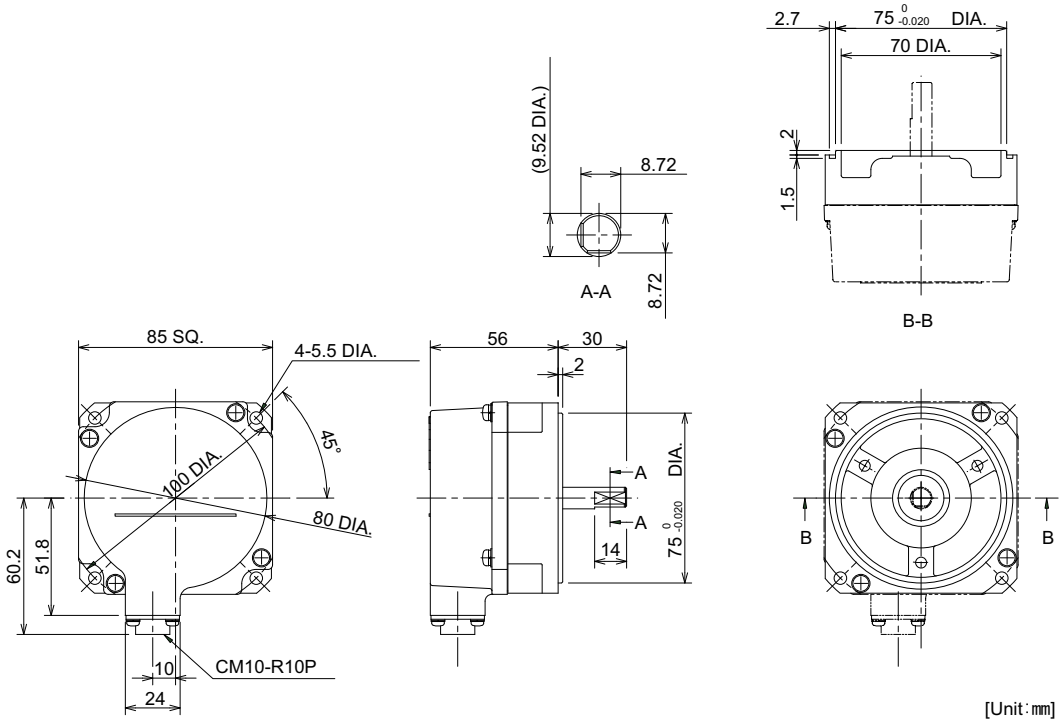
(1) Specifications

Detector type		OSA105-ET2
Electrical characteristics	Detector resolution	1,000,000 pulse/rev
	Detection method	Absolute position method (battery backup method)
	Tolerable rotation speed at power off (Note)	500r/min
	Detector output data	Serial data
	Power consumption	0.3A
Mechanical characteristics for rotation	Inertia	0.5×10^{-4}kgm^2 or less
	Shaft friction torque	0.1Nm or less
	Shaft angle acceleration	4×10^4rad/s^2 or less
	Tolerable continuous rotation speed	4000r/min
Mechanical configuration	Shaft amplitude (position 15mm from end)	0.02mm or less
	Tolerable load (thrust direction/radial direction)	9.8N/19.8N
	Mass	0.6kg
	Degree of protection	IP65 (The shaft-through portion is excluded.)
	Recommended coupling	bellows coupling
Working environment	Ambient temperature	0°C to +55°C
	Storage temperature	-20°C to +85°C
	Humidity	95%Ph
	Vibration resistance	5 to 50Hz, total vibration width 1.5mm, each shaft for 30min
	Impact resistance	490m/s^2 (50G)

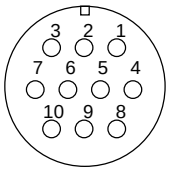
⚠CAUTION If the tolerable rotation speed at power off is exceeded, the absolute position cannot be repaired.

5 Dedicated Options

(2) Outline dimension drawings
OSA105-ET2



(3) Explanation of connectors



Connector pin layout

Pin	Function	Pin	Function
1	RQ	**6**	SD
2	RQ*	**7**	SD*
3	-	**8**	P5(+5V)
4	BAT	**9**	-
5	LG(GND)	**10**	SHD

5-1-3 Machine side detector

The machine side detectors are all other manufacturer's parts, and must be prepared by the user.

(1) Relative position detector

Depending on the output signal specifications, select a machine side relative position detector with which the following (a), (b) or (c) is applied.

(a) Serial signal type (serial conversion unit made by each manufacture)

The following serial conversion unit converts the detector output signal and transmits the signal to the drive unit in serial communication.

For details on the specifications of each conversion unit scale and for purchase, contact each corresponding manufacture directly.

Manufacturer	Detector type	Interface unit type	Minimum detection resolution	Tolerable maximum speed
Magnescale Co., Ltd	SR75 SR85	Not required	0.1μm	200m/min
			0.05μm	
			0.01μm	
HEIDENHAIN	LS187 LS487	EIB192M A4 20μm	0.0012μm	120m/min
		EIB392M A4 20μm		
	ERM280 1200	EIB192M C4 1200	0.0000183° (19,660,800p/rev)	20000r/min
		EIB392M C4 1200		
	ERM280 2048	EIB192M C6 2048	0.0000107° (33,554,432p/rev)	11718r/min
		EIB392M C6 2048		

<Contact information about machine side detector>

- Magnescale Co., Ltd: http://www.mgscale.com/mgs/
- HEIDENHAIN CORPORATION: http://www.heidenhain.de/

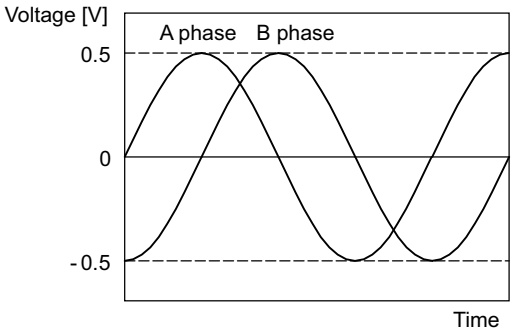
CAUTION ! The above value does not guarantee the accuracy of the system.

(b) SIN wave output (using MDS-B-HR)

When using a relative position detector that the signal is the SIN wave output, the detector output signal is converted in the detector conversion unit (MDS-B-HR), and then the signal is transmitted to the drive unit in the serial communication. Select a relative position detector with A/B phase SIN wave signal that satisfies the following conditions. For details on the specifications of MDS-B-HR, refer to the section "MDS-B-HR".

<Detector output signal>

- 1Vp-p analog A-phase, B-phase, Z-phase differential output
- Output signal frequency 200kHz or less



A/B phase output signal waveform during forward run

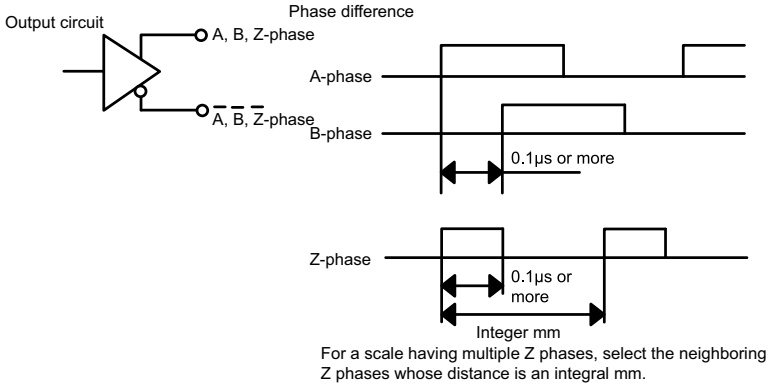
- Combination speed / rotation speed
  - In use of linear scale:
  - Maximum speed (m/min) = scale analog signal frequency (m) x 200,000 x 60
  - In use of rotary encoder:
  - Maximum rotation speed (r/min) = 200,000 / numbers of encoder scale (1/rev) x 60
  - An actual Maximum speed/ rotary speed is limited by the mechanical specifications and electrical specifications, etc. of the connected scale, so contact the manufacture of the purchased scale.
- Division number 512 divisions per 1 cycle of signal
  - In use of linear scale:
  - Minimum resolution (m) = scale analog signal frequency (m) / 512
  - In use of rotary encoder:
  - Minimum resolution (pulse/rev) = numbers of encoder scale (1/rev) x 512

CAUTION ! The above value does not guarantee the accuracy of the system.

(c) Rectangular wave output

Select a relative position detector with an A/B phase difference and Z-phase width at the maximum feedrate that satisfies the following conditions.

Use an A, B, Z-phase signal type with differential output (RS-422 standard product) for the output signal



(Note)The above value is minimum value that can be received normally in the servo drive unit side.
In an actual selection, ensure margin of 20% or more in consideration of degradation of electrical wave and speed overshoot.

< Example of scale specifications >

The example of using representative rectangular wave scale is shown below.
For specifications of each conversion unit and scale and for purchase, Contact each corresponding manufacture directly.

Manufacturer	Detector type	Interface unit type	Minimum detection resolution	Tolerable maximum speed
Magnescale Co., Ltd	SR74 SR84	Not required	1.0μm	180m/min
			0.5μm	125m/min
			0.1μm	25m/min
			0.05μm	12m/min
HEIDENHAIN	LS187 LS487	IBV 101 (10 divisions)	0.5μm	120m/min
		IBV 102 (100 divisions)	0.05μm	24m/min
		IBV 660B (400 divisions)	0.0125μm	7.5m/min

<Contact information about machine side detector>

- Magnescale Co., Ltd: http://www.mgscale.com/mgs/
- HEIDENHAIN CORPORATION: http://www.heidenhain.de/

(2) Absolute position detector

The applicable absolute position detectors are as follows.

Manufacturer	Detector type	Interface unit type	Minimum detection resolution	Tolerable maximum speed
Magnescale Co., Ltd	SR77 SR87	Not required	0.1μm	200m/min
			0.05μm	
			0.01μm	
	RU77	Not required	0.0000429° (8,388,608p/rev)	2,000r/min
			0.0000107 (33,554,432p/rev)	2,000r/min
HEIDENHAIN MitutoyoAT343Not required0.05μm120m/min	LC193M LC493M	Not required	0.05μm	180m/min
			0.01μm	
	RCN223M	Not required	0.0000429° (8,388,608p/rev)	1,500r/min
	RCN227M	Not required	0.0000027° (134,217,728p/rev)	1,500r/min
	RCN727M RCN827M	Not required	0.0000027° (134,217,728p/rev)	300r/min
Mitutoyo	AT343	Not required	0.05μm	120m/min
	AT543	Not required	0.05μm	150m/min
	AT545	Not required	0.00488 (20/4096)μm	150m/min
MHI MACHINE TOOL ENGINEERING CO., LTD	MPRZ series	ADB-20J71	0.000043° (8,388,608p/rev)	10,000r/min
	MPS Series	ADB-20J60	0.05μm	3600m/min
	MPI Series	ADB-20J60	0.00005°(7,200,000p/rev) or 0.000025°(14,400,000p/rev)	5,000r/min
FAGOR	SAM Series	Not required	0.05μm	120m/min
	SVAM Series	Not required	0.05μm	120m/min
	GAM Series	Not required	0.05μm	120m/min
	LAM Series	Not required	0.1μm	120m/min

<Contact information about machine side detector>

- Magnescale Co., Ltd: http://www.mgscale.com/mgs/
- HEIDENHAIN CORPORATION: http://www.heidenhain.de/
- Mitutoyo Corporation: http://www.mitutoyo.co.jp/
- MHI MACHINE TOOL ENGINEERING CO., LTD: http://www.mme-e.co.jp/
- FAGOR Automation: http://www.fagorautomation.com/

CAUTION ! Confirm specifications of each detector manufacturer before using the machine side detector.

5-2 Spindle options

According to the spindle control to be adopted, select the spindle side detector based on the following table.

(a) No-variable speed control
(When spindle and motor are directly coupled or coupled with a 1:1 gear ratio)

Spindle control item	Control specifications	Without spindle side detector	With spindle side detector
Spindle control	Normal cutting control	●	This normally is not used for no-variable speed control.
	Constant surface speed control (lathe)	●	
	Thread cutting (lathe)	●	
Orientation control	1-point orientation control	●	
	Multi-point orientation control	●	
	Orientation indexing	●	
Synchronous tap control	Standard synchronous tap	●	
	Synchronous tap after zero point return	●	
Spindle synchro-nous control	Without phase alignment function	●	
	With phase alignment function	●	
C-axis control	C-axis control	● (Note 2)	•

(Note 1) ● :Control possible
x :Control not possible
(Note 2) When spindle and motor are coupled with a 1:1 gear ratio, use of a spindle side detector is recommended to assure the precision.

(b) Variable speed control
(When using V-belt, or when spindle and motor are connected with a gear ratio other than 1:1)

Spindle control item	Control specifications	Without spindle side detector	With spindle side detector		
			TS5690/ERM280/ MPCI Series	OSE-1024	Proximity switch
Spindle control	Normal cutting control	●	●	●	-
	Constant surface speed control (lathe)	● (Note 2)	●	●	x
	Thread cutting (lathe)	x	●	●	x
Orientation control	1-point orientation control	x	●	●	●
	Multi-point orientation control	x	●	●	x
	Orientation indexing	x	●	●	x
Synchronous tap control	Standard synchronous tap	● (Note 3)	●	●	x
	Synchronous tap after zero point return	x	●	●	x
Spindle syn-chronous control	Without phase alignment function	● (Note 2)	●	●	x
	With phase alignment function	x	●	●	x
C-axis control	C-axis control	x	●	x	x

(Note 1) ● :Control possible
x :Control not possible
(Note 2) Control not possible when connected with the V-belt.
(Note 3) Control not possible when connected with other than the gears.

(c) Cautions for connecting the spindle end with an OSE-1024 detector
[1] Confirm that the gear ratio (pulley ratio) of the spindle end to the detector is 1:1.
[2] Use a timing belt when connecting by a belt.

5-2-1 Spindle side ABZ pulse output detector (OSE-1024 Series)

When a spindle and motor are connected with a V-belt, or connected with a gear ratio other than 1:1, use this spindle side detector to detect the position and speed of the spindle. Also use this detector when orientation control and synchronous tap control, etc are executed under the above conditions.

(1) Specifications

Detector type		OSE-1024-3-15-68	OSE-1024-3-15-68-8
Mechanical characteristics for rotation	Inertia	$0.1x10^{-4}kgm^2$ or less	$0.1x10^{-4}kgm^2$ or less
	Shaft friction torque	0.98Nm or less	0.98Nm or less
	Shaft angle acceleration	$10^4rad/s^2$ or less	$10^4rad/s^2$ or less
	Tolerable continuous rotation speed	6000 r/min	8000 r/min
Mechanical configuration	Bearing maximum non-lubrication time	20000h/6000r/min	20000h/8000r/min
	Shaft amplitude (position 15mm from end)	0.02mm or less	0.02mm or less
	Tolerable load (thrust direction/radial direction)	10kg/20kg Half of value during operation	10kg/20kg Half of value during operation
	Mass	1.5kg	1.5kg
	Squareness of flange to shaft	0.05mm or less	
	Flange matching eccentricity	0.05mm or less	
Working environment	Ambient temperature range	-5°C to +55°C	
	Storage temperature range	-20°C to +85°C	
	Humidity	95%Ph	
	Vibration resistance	5 to 50Hz, total vibration width 1.5mm, each shaft for 30min.	
	Impact resistance	$294.20m/s^2$ (30G)	

(Note) Confirm that the gear ratio (pulley ratio) of the spindle end to the detector is 1:1.

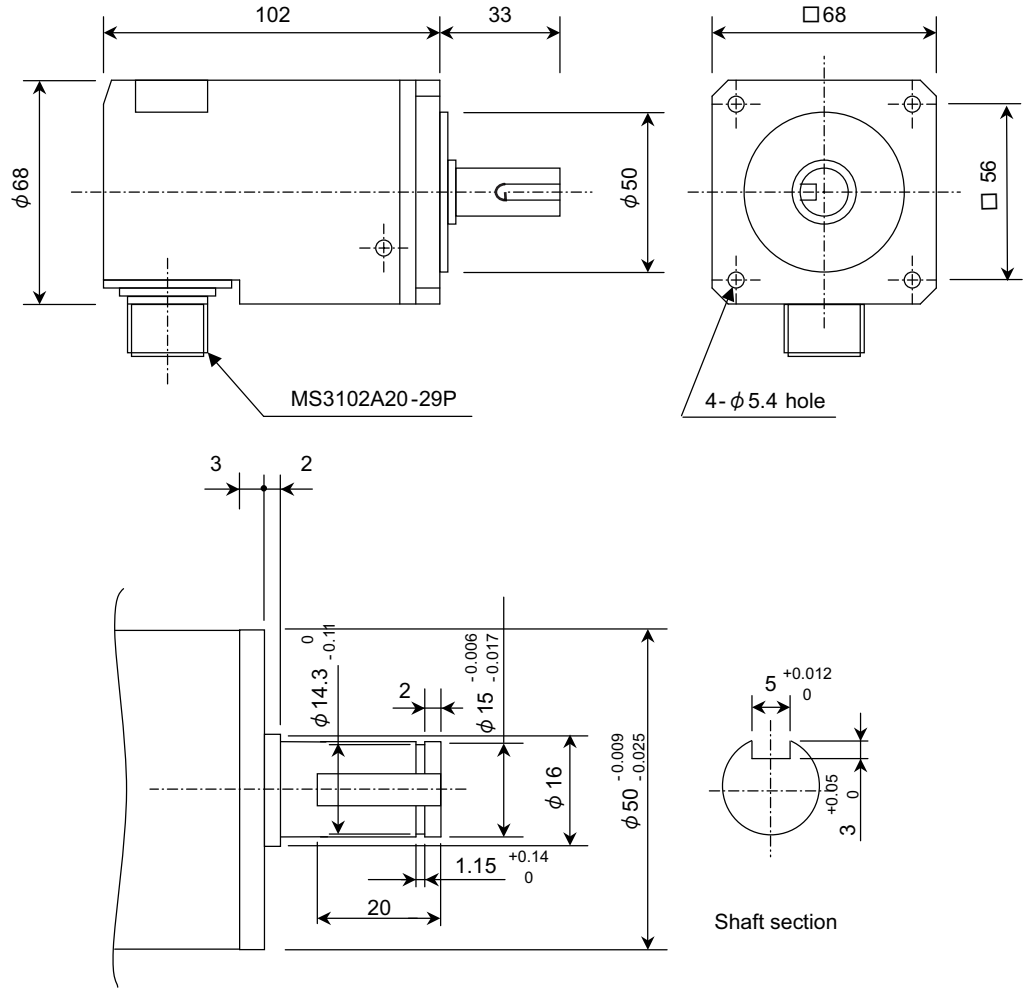
(2) Detection signals

Signal name	Number of detection pulses
A, B phase	1024p/rev
Z phase	1p/rev

Connector pin layout

Pin	Function	Pin	Function
A	A+ signal	K	0V
B	Z+ signal	L	-
C	B+ signal	M	-
D	-	N	A- signal
E	Case grounding	P	Z- signal
F	-	R	B- signal
G	-	S	-
H	+5V	T	-
J	-		

(3) Outline dimension drawings



[Unit: mm]

Spindle side detector (OSE-1024-3-15-68, OSE-1024-3-15-68-8)

5-2-2 Spindle side PLG serial output detector (TS5690, MU1606 Series)

This detector is used when a more accurate synchronous tapping control or C-axis control than OSE detector is performed to the spindle which is not directly-connected to the spindle motor.

(1) Type configuration

<Sensor type>

TS5690N (1) (2)

(1)

Symbol	The number of compatible detection gear teeth
64	64
12	128
25	256

(2)

Symbol	Length of the cable
10	400mm
20	800mm
30	1200mm
40	1600mm
60	2000mm

<Detection gear type>

MU1606N (1) (2)

(1)

Symbol	The number of detection gear teeth
6	64
7	128
8	256

(2) Each specification number

(2) Specifications

	Series type	TS5690N64xx					TS5690N12xx					TS5690N25xx				
Sensor	xx (The end of the type name)	10	20	30	40	60	10	20	30	40	60	10	20	30	40	60
	Length of lead [mm]	400 ±10	800 ±20	1200 ±20	1600 ±30	2000 ±30	400 ±10	800 ±20	1200 ±20	1600 ±30	2000 ±30	400 ±10	800 ±20	1200 ±20	1600 ±30	2000 ±30
Detection gear	Type	MU1606N601					MU1606N709					MU1606N805				
	The number of teeth	64					128					256				
	Outer diameter [mm]	φ52.8					φ104.0					φ206.4				
	Inner diameter [mm]	φ40H5					φ80H5					φ140H5				
	Thickness [mm]	12					12					14				
	Shrink fitting [mm]	0.020 to 0.040					0.030 to 0.055					0.050 to 0.085				
Notched fitting section	Outer diameter [mm]	φ72.0					φ122.0					φ223.6				
	Outer diameter tolerance [mm]	+0.010 to +0.060					-0.025 to +0.025					-0.025 to +0.025				
The number of output pulse	A/B phase	64					128					256				
	Z phase	1					1					1				
Detection resolution [p/rev]		2 million					4 million					8 million				
Absolute accuracy at stop		150"					100"					95"				
Tolerable speed [r/min]		40,000					20,000					10,000				
Signal output		Mitsubishi high-speed serial														

CAUTION !

1.Selected detectors must be able to tolerate the maximum rotation speed of the spindle.

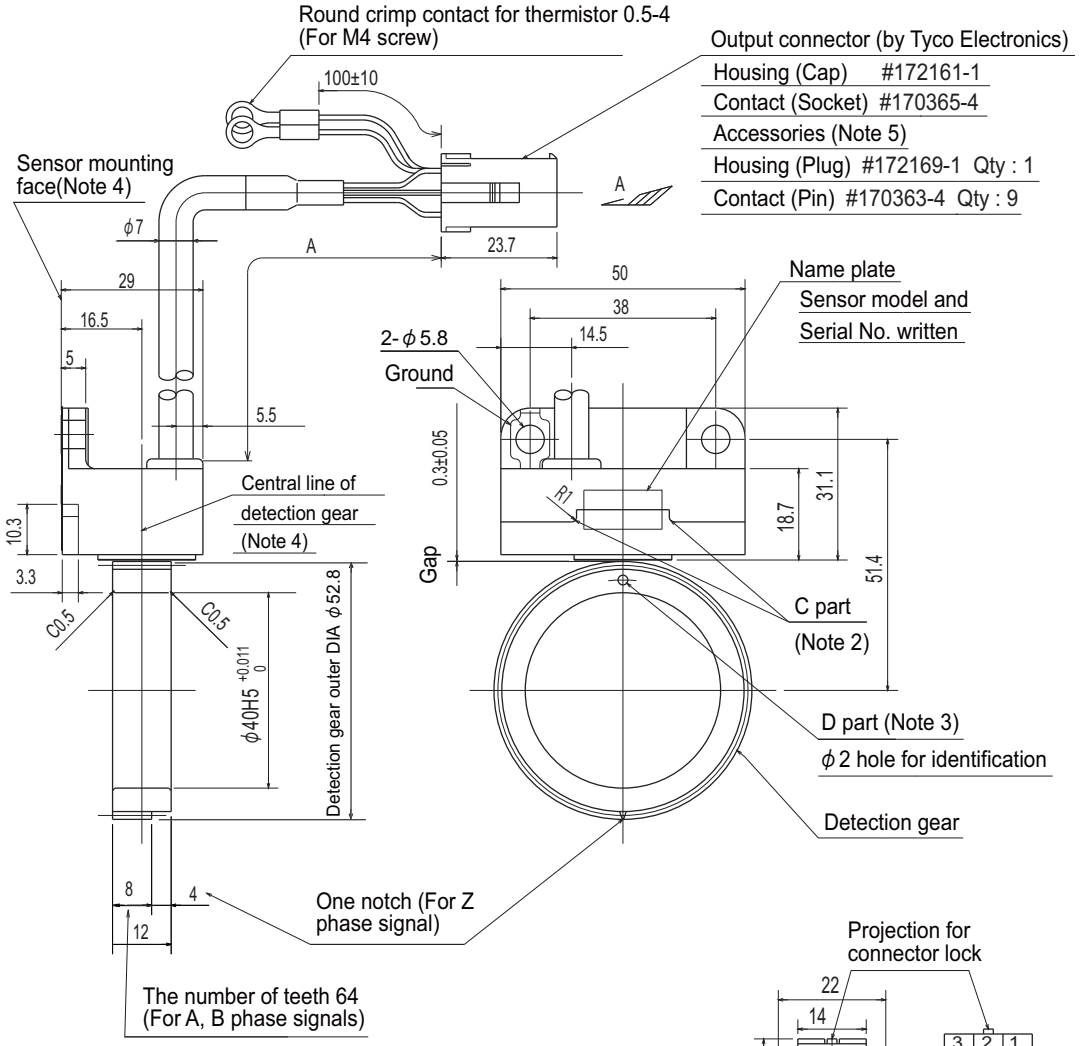
2.Please contact your Mitsubishi Electric dealer for the special products not listed above.

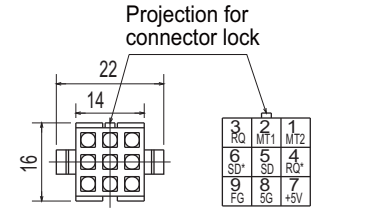
(3) Outline dimension drawings

CAUTION ! Always apply the notched fitting section machining with the specified dimensions to the sensor installation surface.

<TS5690N64xx + MU1606N601>

[Unit: mm]





(Note 1) Handle with care as this is a precision component.
Pay special attention not to apply excessive external force on the sensor's detection face. Applying such force will cause a fault.

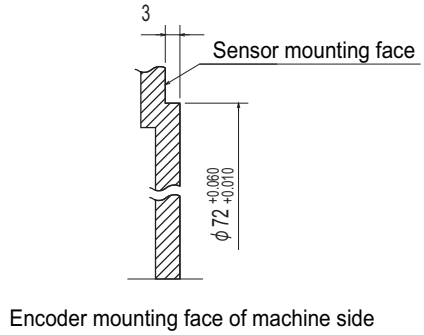
(Note 2) In installing the sensor, keep the protruding fitting of $\phi 72^{+0.060}_{+0.010}$ mm on the machine side, and push the C part of the sensor mounting seat against the fitting.

(Note 3) In installing the detection gear, make sure that the D part side comes the opposite side of the sensor installation side (sensor's lead wire side).

(Note 4) The diviation of the center of the detection gear is 16.5±0.25mm from the sensor mounting face.

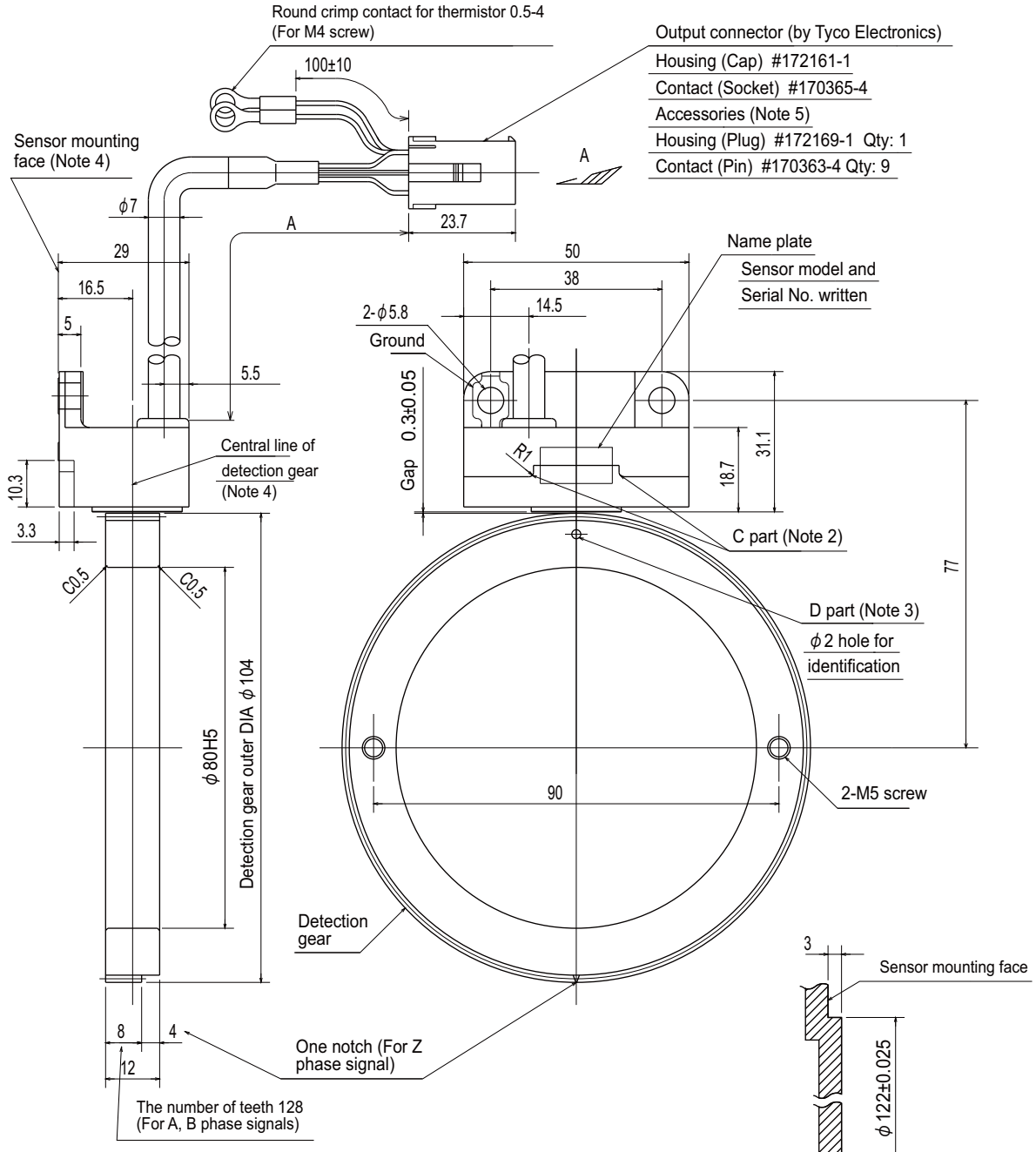
(Note 5) A connector of the signal cable side (one plug and nine pins) is attached.

Sensor		Detection gear
Parts name	Lead wire length A [mm]	Parts name
TS5690N6410	400±10	MU1606N601
TS5690N6420	800±20	
TS5690N6430	1200±20	
TS5690N6440	1600±30	
TS5690N6460	2000±30	



<TS5690N12xx + MU1606N709>

[Unit: mm]



(Note 1) Handle with care as this is a precision component. Pay special attention not to apply excessive external force on the sensor's detection face. Applying such force will cause a fault.

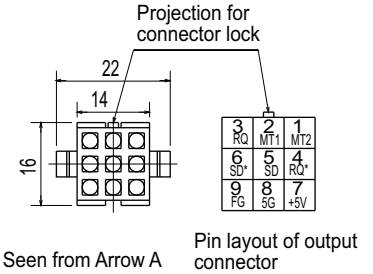
(Note 2) In installing the sensor, keep the protruding fitting of ϕ122±0.025 mm on the machine side, and push the C part of the sensor mounting seat against the fitting.

(Note 3) In installing the detection gear, make sure that the D part side comes the opposite side of the sensor installation side (sensor's lead wire side).

(Note 4) The diviation of the center of the detection gear is 16.5±0.25mm from the sensor mounting face.

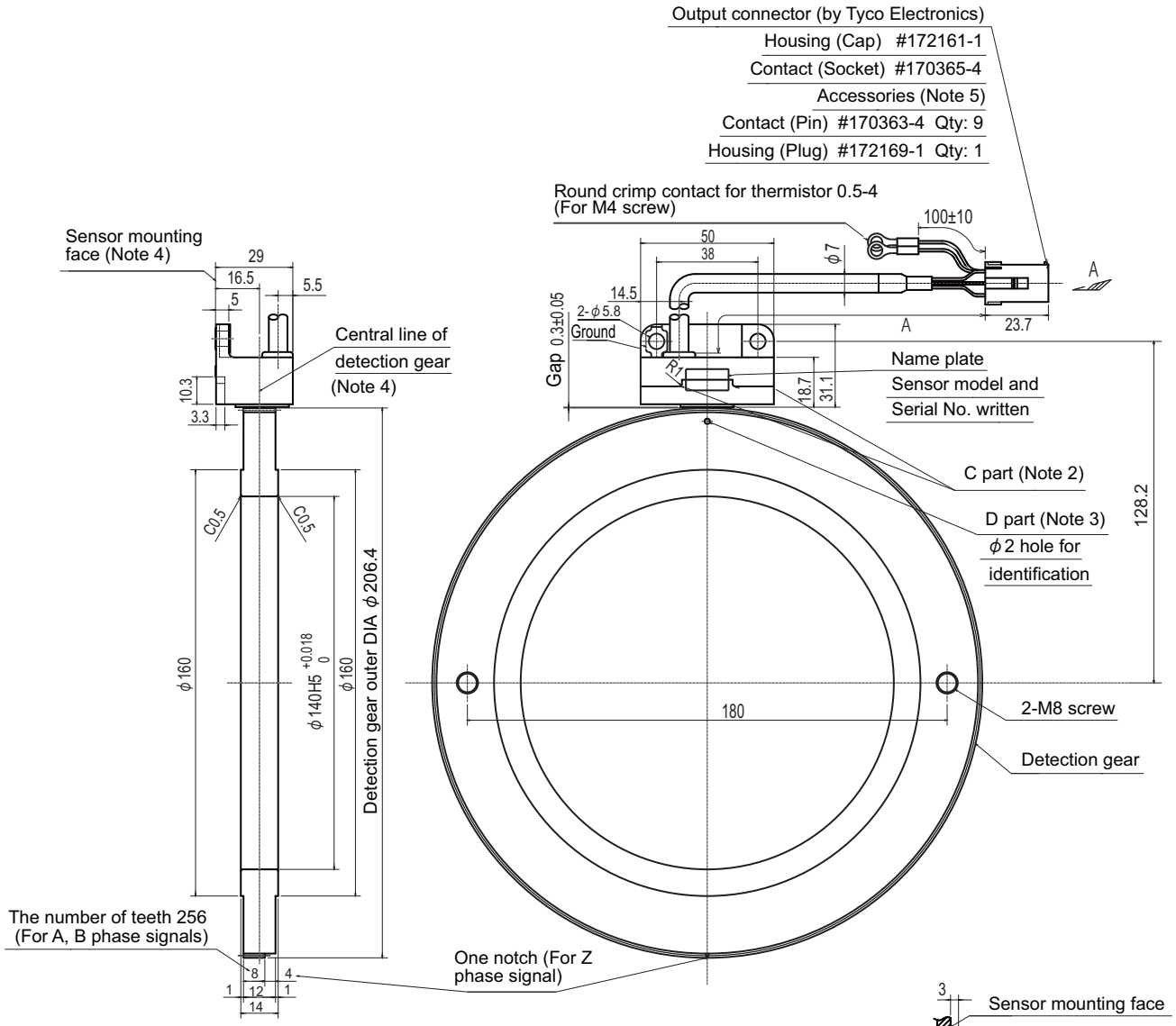
(Note 5) A connector of the signal cable side (one plug and nine pins) is attached.

Sensor		Detection gear
Parts name	Lead wire length A [mm]	Parts name
TS5690N1210	400±10	MU1606N709
TS5690N1220	800±20	
TS5690N1230	1200±20	
TS5690N1240	1600±30	
TS5690N1260	2000±30	



<TS5690N25xx + MU1606N805>

[Unit: mm]



(Note 1) Handle with care as this is a precision component.
Pay special attention not to apply excessive external force on the sensor's detection face. Applying such force will cause a fault.

(Note 2) In installing the sensor, keep the protruding fitting of φ223.6±0.025 mm on the machine side, and push the C part of the sensor mounting seat against the fitting.

(Note 3) In installing the detection gear, make sure that the D part side comes the opposite side of the sensor installation side (sensor's lead wire side).

(Note 4) The diviation of the center of the detection gear is 16.5±0.25mm from the sensor mounting face.

(Note 5) A connector of the signal cable side (one plug and nine pins) is attached.

Sensor		Detection gear
Parts name	Lead wire length A [mm]	Parts name
TS5690N2510	400±10	MU1606N805
TS5690N2520	800±20	
TS5690N2530	1200±20	
TS5690N2540	1600±30	
TS5690N2560	2000±30	

5-2-3 Spindle side accuracy serial output detector (ERM280, MPCI Series)

C-axis control detector is used in order to perform an accurate C-axis control.

Manufacturer	Detector type	Interface unit type	Minimum detection resolution	Tolerable maximum speed
HEIDENHAIN	ERM280 1200	EIB192M C4 1200	0.0000183° (19,660,800p/rev)	20000 r/min
		EIB392M C4 1200		
	ERM280 2048	EIB192M C6 2048	0.0000107° (33,554,432p/rev)	11718 r/min
		EIB392M C6 2048		
MHI MACHINE TOOL ENGINEERING CO., LTD	MPCI series	ADB-20J20	0.00005° (7200000p/rev)	10000 r/min

<Contact information about machine side detector>

- HEIDENHAIN CORPORATION: http://www.heidenhain.de/
- MHI MACHINE TOOL ENGINEERING CO., LTD: http://www.mme-e.co.jp/

CAUTION ! Confirm specifications of each detector manufacturer before using the machine side detector.

5-3 Detector interface unit

5-3-1 Serial output interface unit for ABZ analog detector MDS-B-HR

This unit superimposes the scale analog output raw waves, and generates high resolution position data.Increasing the detector resolution is effective for the servo high-gain. MDS-B-HR-12(P) is used for the synchronous control system that 1-scale 2-drive operation is possible and not used in MDS-D-SVJ3.

(1) Type configuration

MDS-B-HR- (1) (2)

(1) Signal division function class

Symbol	Scale output voltage class
11	Output number 1
12	Output number 2 (with division)

(2) Degree of protection

Symbol	Degree of protection
None	IP65
P	IP67

(2) Specifications

Type MDS-B-HR-	11	12	11P	12P
Compatible scale (example)	LS186 / LS486 (HEIDENHAIN)			
Signal 2-division function	-	*	-	*
Analog signal input specifications	A-phase, B-phase, Z-phase (Amplitude 1Vp-p)			
Compatible frequency	Analog raw waveform max. 200kHz			
Scale resolution	Analog raw waveform/512 division			
Input/output communication style	High-speed serial communication I/F, RS485 or equivalent			
Working ambient temperature	0 to 55°C			
Working ambient humidity	90%RH or less (with no dew condensation)			
Atmosphere	No toxic gases			
Tolerable vibration	98.0 m/s^2 (10G)			
Tolerable impact	294.0 m/s^2 (30G)			
Tolerable power voltage	5VDC±5%			
Maximum heating value	2W			
Mass	0.5kg or less			
Degree of protection	IP65		IP67	

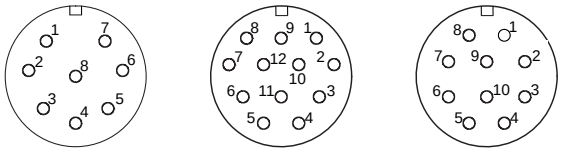
(3) Explanation of connectors

Connector name	Application	Remarks
CON1	For connection with servo drive unit (2nd system)	Not provided for 1-part system specifications
CON2	For connection with servo drive unit	
CON3	For connection with scale	
CON4	For connection with pole detection unit (MDS-B-MD)	*Used for linear servo system

CON1		CON2		CON3		CON4	
Pin No.	Function	Pin No.	Function	Pin No.	Function	Pin No.	Function
1	RQ+ signal	1	RQ+ signal	1	A+ phase signal	1	A phase signal
2	RQ- signal	2	RQ- signal	2	A- phase signal	2	REF signal
3	SD+ signal	3	SD+ signal	3	B+ phase signal	3	B phase signal
4	SD- signal	4	SD- signal	4	B- phase signal	4	REF signal
5	P5	5	P5	5	Z+ phase signal	5	P24
6	P5	6	P5	6	Z- phase signal	6	MOH signal
7	GND	7	GND	7	-	7	P5
8	GND	8	GND	8	-	8	P5
				9	-	9	TH signal
				10	-	10	GND
				11	P5		
				12	GND		

<Connector pin layout >

Connector	Type
CON1	RM15WTR- 8P(Hirose Electric)
CON2	
CON3	RM15WTR-12S(Hirose Electric)
CON4	RM15WTR-10S(Hirose Electric)

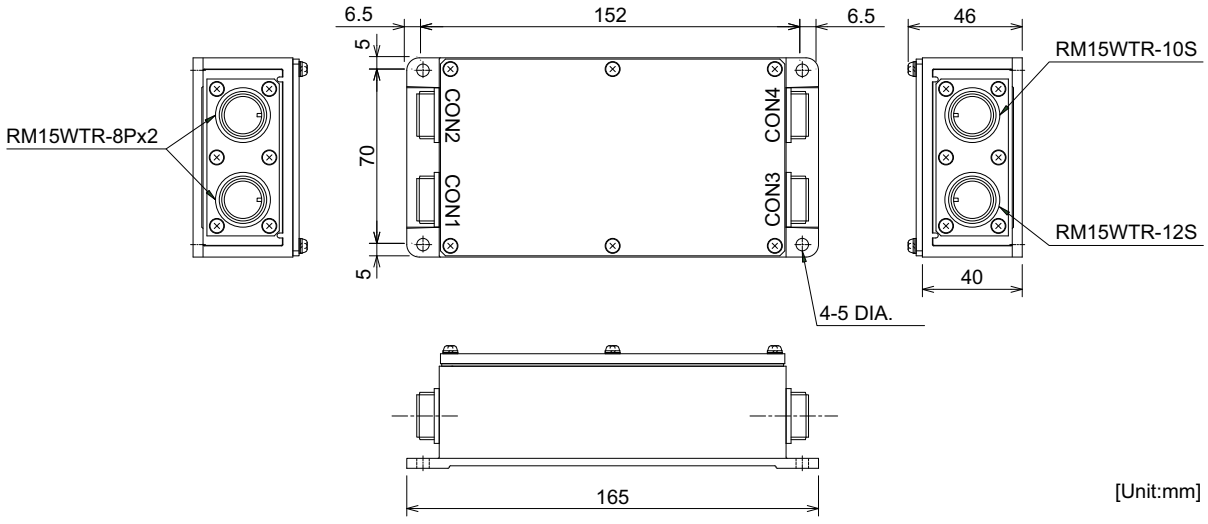


CON1
CON2

CON3

CON4

(4) Outline dimension drawings



[Unit:mm]

5-3-2 Pulse output interface unit for ABZ analog detector IBV Series (Other manufacturer's product)

(1) Appearance

IBV100 series

IBV600 series

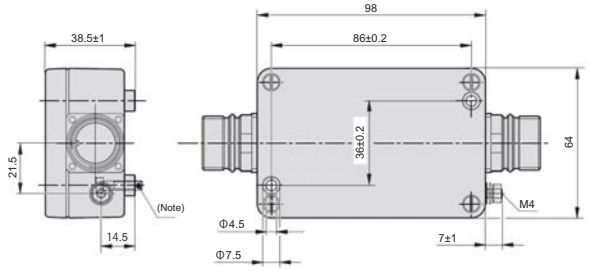
(2) Specifications

Type	IBV 101	IBV 102	IBV 660B
Manufacturer	HEIDENHAIN		
Input signal	A-phase, B-phase: SIN wave 1Vpp, Z-phase		
Maximum input frequency	400kHz		
Output signal	Rectangular wave pulse signal		
Interpolation division number	Maximum 10 divisions	Maximum 100 divisions	Maximum 400 divisions
Compatible detector	LS187, LS487	LS187, LS487	LS187, LS487
Minimum detection resolution	0.5μm	0.05μm	0.0125μm
Working temperature	0°C to 70°C		
Degree of protection	IP65		
Mass	300g		

CAUTION ! These are other manufacturer's products. When purchasing these product, contact the manufacturer directly.

(3) Outline dimension drawings

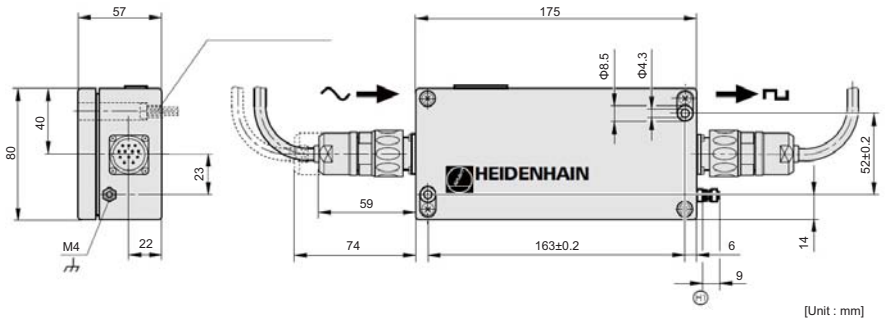
IBV100 series



(Note) This can be fixed with two screws.
M4 × 16 ISO 4762/DIN 912

[Unit: mm]

IBV600 series



[Unit : mm]

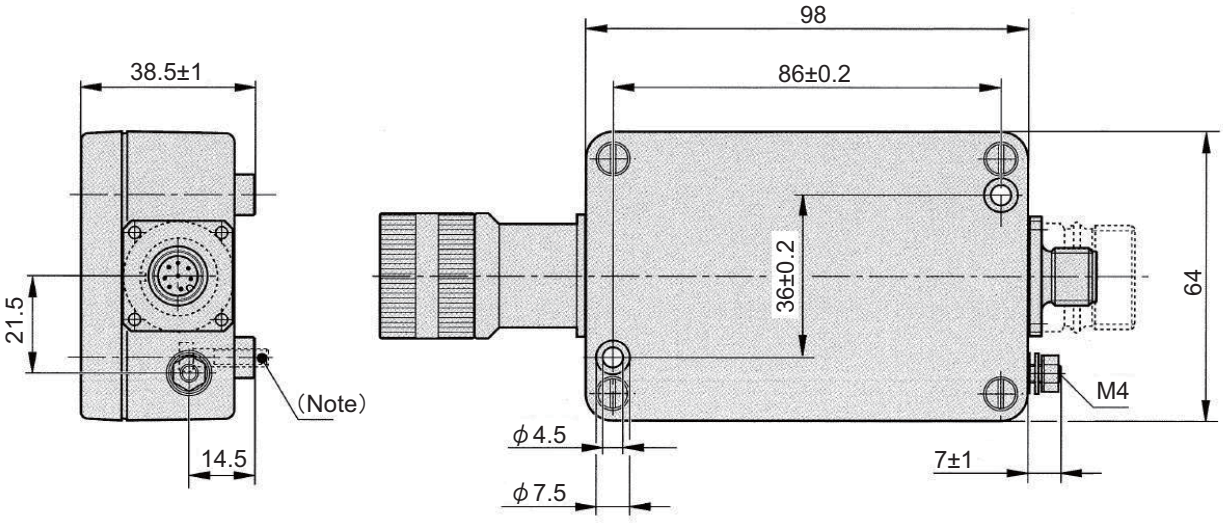
5-3-3 Serial output interface unit for ABZ analog detector EIB192M (Other manufacturer's product)

(1) Appearance

(2) Specifications

Type	EIB192M A4 20µm	EIB192M C4 1200	EIB192M C4 2048
Manufacturer	HEIDENHAIN		
Input signal	A-phase, B-phase: SIN wave 1Vpp, Z-phase		
Maximum input frequency	400kHz		
Output signal	Mitsubishi high-speed serial signal (MITSU02-4)		
Interpolation division number	Maximum 16384 divisions		
Compatible detector	LS187, LS487	ERM280 1200	ERM280 2048
Minimum detection resolution	0.0012µm	0.0000183° (19,660,800p/rev)	0.0000107° (33,554,432p/rev)
Working temperature	0°C to 70°C		
Degree of protection	IP65		
Mass	300g		

(3) Outline dimension drawings



（Note）Two fixing screws（M4×16 DIN 912/ISO 4762）　　[Unit : mm]

CAUTION ! These are other manufacturer's products. When purchasing these product, contact the manufacturer directly.

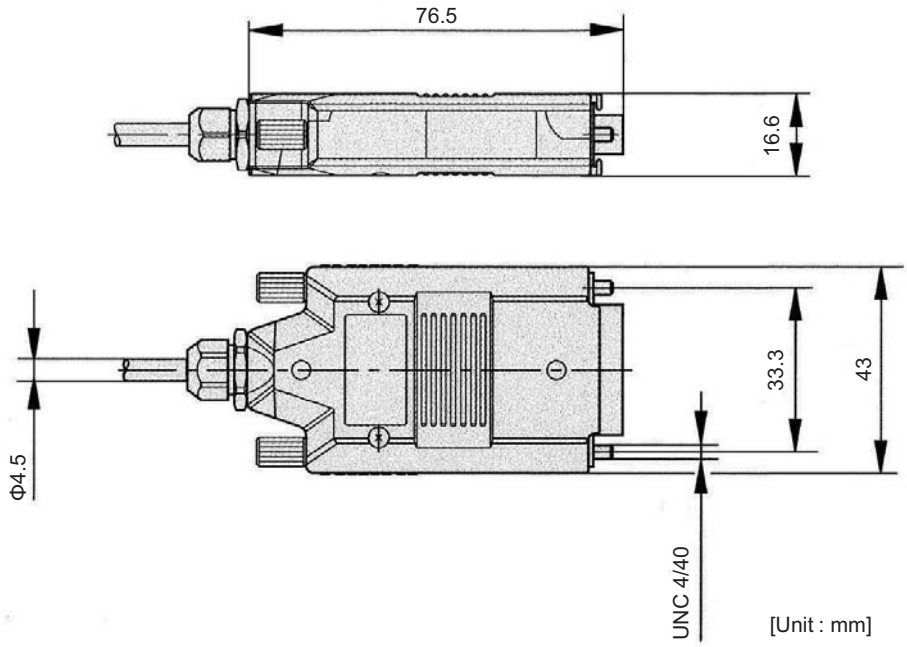
5-3-4 Serial output interface unit for ABZ analog detector EIB392M (Other manufacturer's product)

(1) Appearance

(2) Specifications

Type	EIB392M A4 20μm	EIB392M C4 1200	EIB392M C4 2048
Manufacturer	HEIDENHAIN		
Input signal	A-phase, B-phase: SIN wave 1Vpp, Z-phase		
Maximum input frequency	400kHz		
Output signal	Mitsubishi high-speed serial signal (MITSU02-4)		
Interpolation division number	Maximum 16384 divisions		
Compatible detector	LS187, LS487	ERM280 1200	ERM280 2048
Minimum detection resolution	0.0012μm	0.0000183° (19,660,800p/rev)	0.0000107° (33,554,432p/rev)
Working temperature	0°C to 70°C		
Degree of protection	IP40		
Mass	140g		

(3) Outline dimension drawings



CAUTION ! These are other manufacturer's products. When purchasing these product, contact the manufacturer directly.

5-3-5 Serial output interface unit for ABZ analog detector ADB-20J Series (Other manufacturer's product)

(1) Appearance

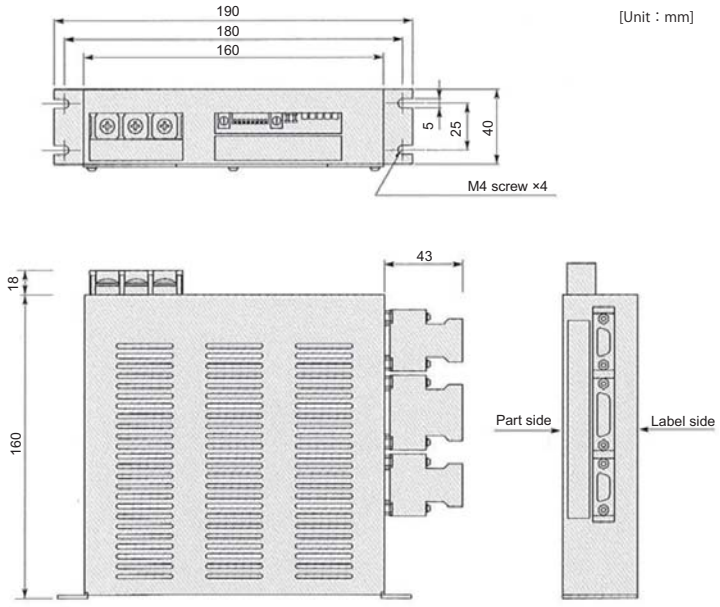
(2) Specifications

Type	ADB-20J20	ADB-20J60		ADB-20J71
Manufacturer	MHI MACHINE TOOL ENGINEERING CO., LTD			
Maximum response speed	10,000r/min	3,600m/min	5,000r/min	10,000r/min
Output signal	Mitsubishi high-speed serial signal			
Compatible detector	MPCI series	MPS Series	MPI Series	MPRZ series
Minimum detection resolution	0.00005° (7,200,000p/rev)	0.05μm	0.000025° (1,440,000p/rev)	0.000043° (8,388,608p/rev)
Working temperature	0°C to 55°C			
Degree of protection	IP20			
Mass	0.9kg			

CAUTION ! These are other manufacturer's products. When purchasing these product, contact the manufacturer directly.

(3) Outline dimension drawings

[Unit : mm]



5-4 Drive unit option

5-4-1 Optical communication repeater unit (FCU7-EX022)

When the distance of the optical communication cable between NC control unit and drive unit is over 30m (M700V/M70V Series: maximum 30m, M700/M70/C70 Series: maximum 20m), the communication can be performed by relaying the optical signal.
Using up to two units, relay of the total length of up to 90m (M700V/M70V Series: maximum 90m, M700/M70/C70 Series: maximum 60m) can be performed.

<Product features>

(a) When the distance of the optical communication cable between NC control unit and drive unit is over 30m, the communication can be performed by relaying the optical signal.
(b) The relay between NC control unit and drive unit can be performed for up to two channels.
(c) If the distance between NC control unit and drive unit is even within 30m, the cable can be divided by the relay in transporting the machine.
(d) Same mounting dimension as the remote I/O unit (DX unit).

CAUTION ! This unit can not be used between drive units.

(1) Specifications

Item			
24VDC input	Input voltage		24V±10% (21.6V to 26.4V)
	Inrush current		35A
	Power consumption		10W
	Consumption current		0.4A
Optical interface	Channel number		2 channels
	Connectable number		Maximum 2
Environment	Ambient temperature	Operation	0°C to +55°C
		Storage	-20°C to +60°C
	Ambient humidity	Operation (long term)	+10%RH to +75%RH (with no dew condensation)
		Operation (short term)	+10%RH to +95%RH (with no dew condensation. Short term is within about one month.)
		Storage	+10%RH to +75%RH (with no dew condensation)
	Vibration	Operation	4.9m/s^2
		Transportation	34.3m/s^2
	Impact resistance	Operation	29.4m/s^2
	Atmosphere		No corrosive gas, oil mist, or dust
Dimension	Dimension		(depth)135mm × (width)40mm × (height)168mm
	Mounting method		Screw cramp with M5 2 screw cramps
Mass			0.42kg

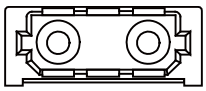
(2) Explanation of connectors

Connector name	Application	Remarks
OPT1IN, OPT1OUT, OPT2IN, OPT2OUT	Optical connector	
DCIN	24VDC Power connector	
DCOUT	24VDC/ Power OFF detection output connector	Relays the PD25/27 output to NC control unit.
ACFAIL	Power OFF detection connector	Relays the power OFF detection signal (ACFAIL) when sharing 24V power from PD25/PD27 for NC control unit and optical communication repeater unit. It will not be used when dedicated general-purpose power supply for optical communication repeater unit is prepared.
FG	FG Faston terminal	

DCIN		DCOUT				ACFAIL	
Pin No.	**Name**	**Pin No.**	**Name**	**Pin No.**	**Name**	**Pin No.**	**Name**
1	24VDC	**A1**	ACFAIL	**B1**	24VDC	**1**	COM
2	0V (RG)	**A2**	COM	**B2**	0V (RG)	**2**	ACFAIL
3	FG	**A3**	NC	**B3**	FG		

< Connector pin layout >

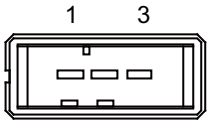
Optical communication I/F (OPT1IN, OPT1OUT, OPT2IN, OPT2OUT)



<Cable side connector type>

(PCF type)
Connector : CF-2D101-S
Recommended manufacturer: Japan Aviation Electronics
(POF type)
Connector :PF-2D101
Recommended manufacturer: Japan Aviation Electronics

DC24V input (DCIN)



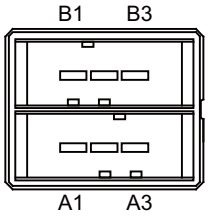
<PCB side connector type>

Connector: 2-178293-5
Recommended manufacturer: Tyco Electronics

<Cable side connector type>

Connector: 2-178288-3
Contact: 1-175218-5
Recommended manufacturer: Tyco Electronics

DC24V output (DCOUT)



<PCB side connector type>

Connector: 3-178137-5

Recommended manufacturer: Tyco Electronics

<Cable side connector type>

Connector: 2-178127-6

Contact: 1-175218-5

Recommended manufacturer: Tyco Electronics

Power OFF input ACFAIL (Terminal name:CF01)

<PCB side connector type>

Connector: 53103-0230

Recommended manufacturer: MOLEX

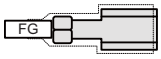
<Cable side connector type>

connector: 51030-0230

Contact: 50084-8160

Recommended manufacturer: MOLEX

FG terminal (FG)

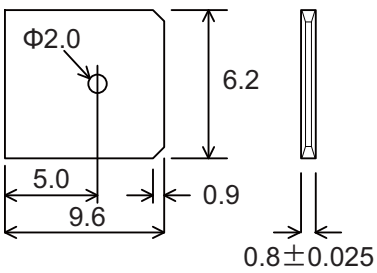


<Cable side faston terminal type name>

Type name: 175022-1(For AWG20-14 250 series)

Recommended manufacturer: Tyco Electronics

Terminal protection tube: 174817-2 (Yellow)

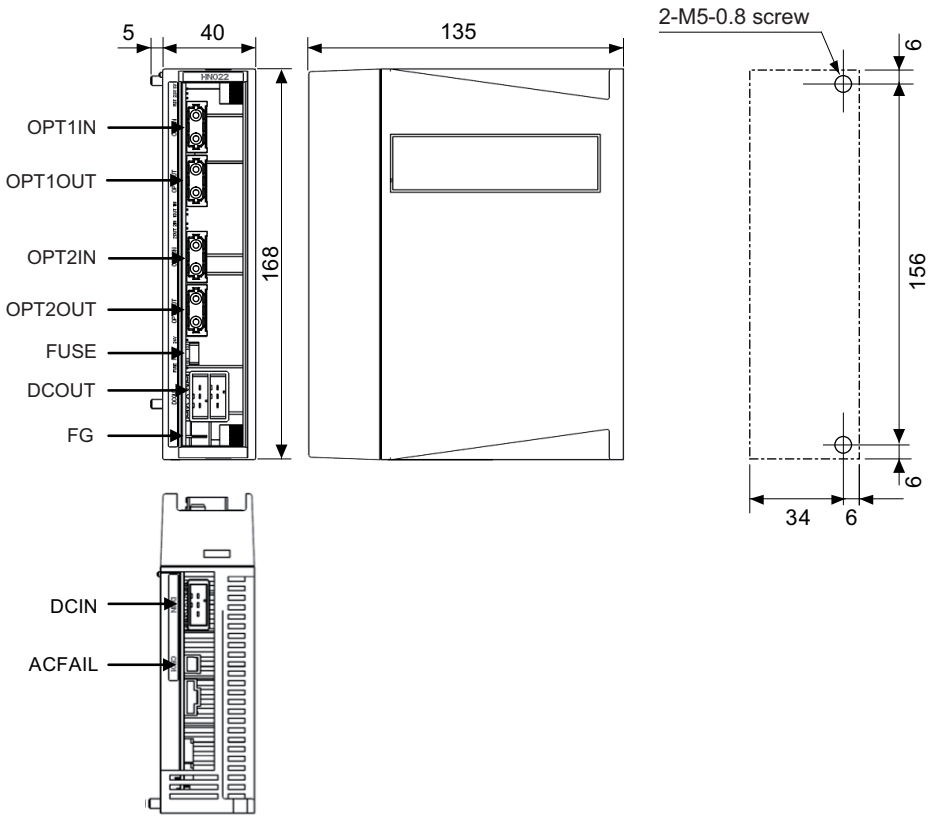


Unit side tab terminal shape

(Note) The faston terminal "175022-1" of the cable side is a simple lock type. Make sure to insert until the simple lock pin is in the Φsecond hole. Firmly press the simple lock release tab when unplugging it.

(3) Outline dimension drawings

[Unit: mm]



5-4-2 Regenerative option

Confirm the regeneration resistor capacity and possibility of connecting with the drive unit. Refer to "7-2 Selection of the regenerative resistor" for details on selecting an regenerative resistor.
The regenerative resistor generates heats, so wire and install the unit while taking care to safety. When using the regenerative resistor, make sure that flammable matters, such as cables, do not contact the resistor, and provide a cover on the machine so that dust or oil does not accumulate on the resistor and ignite.

(1) Combination with servo drive unit

Corresponding servo drive unit	Standard built-in regenerative resistor		External option regenerative resistor						
			MR-RB032	MR-RB12	MR-RB32	MR-RB30	MR-RB50	MR-RB31	MR-RB51
					GZG200W120OHMK ×3 units	GZG200W39OHMK ×3 units	GZG300W39OHMK ×3 units	GZG200W20OHMK ×3 units	GZG300W20OHMK ×3 units
	Parameter setting value		1200h	1300h	1400h	1500h	1600h	1700h	1800h
	Regenerative capacity		30W	100W	300W	300W	500W	300W	500W
		Resistance value	40Ω	40Ω	40Ω	13Ω	13Ω	6.7Ω	6.7Ω
MDS-D-SVJ3-03NA	10W	100Ω	○	○					
MDS-D-SVJ3-04NA	10W	100Ω	○	○					
MDS-D-SVJ3-07NA	20W	40Ω	○	○	○				
MDS-D-SVJ3-10NA	100W	13Ω				○	○		
MDS-D-SVJ3-20NA	100W	9Ω						○	○
MDS-D-SVJ3-35NA	100W	9Ω						○	○

Corresponding servo drive unit	Standard built-in regenerative resistor		External option regenerative resistor					
			FCUA-RB22	FCUA-RB37	FCUA-RB55	R-UNIT2	FCUA-RB55 2 units connected in parallel	FCUA-RB75/2 2 units connected in parallel
	Parameter setting value		2400h	2500h	2600h	2900h	2E00h	2D00h
	Regenerative capacity		155W	185W	340W	700W	680W	680W
		Resistance value	40Ω	25Ω	20Ω	15Ω	10Ω	15Ω
MDS-D-SVJ3-03NA	10W	100Ω						
MDS-D-SVJ3-04NA	10W	100Ω						
MDS-D-SVJ3-07NA	20W	40Ω	○					
MDS-D-SVJ3-10NA	100W	13Ω		○	○	○		○
MDS-D-SVJ3-20NA	100W	9Ω				○	○	○
MDS-D-SVJ3-35NA	100W	9Ω					○	

(2) Combination with servo drive unit

⚠CAUTION The regenerative resistor is not incorporated in the spindle drive unit. Make sure to install the external option regenerative resistor.

Corresponding spindle drive unit		External option regenerative resistor			
		MR-RB12	MR-RB32	MR-RB30	MR-RB50
		GZG200W39OHMK	GZG200W120 OHMK×3 units	GZG200W39 OHMK×3 units	GZG300W39 OHMK×3 units
	Parameter setting value	1300h	1400h	1500h	1600h
	Regenerative capacity	100W	300W	300W	500W
	Resistance value	40Ω	40Ω	13Ω	13Ω
MDS-D-SPJ3-075NA	---	○	○		
MDS-D-SPJ3-22NA	---			○	○
MDS-D-SPJ3-37NA	---			○	○
MDS-D-SPJ3-55NA	---			○	○
MDS-D-SPJ3-75NA	---				○
MDS-D-SPJ3-110NA	---				

Corresponding spindle drive unit		External option regenerative resistor			
		FCUA-RB22	FCUA-RB37	FCUA-RB55	FCUA-RB75/2 (1 unit)
	Parameter setting value	2400h	2500h	2600h	2700h
	Regenerative capacity	155W	185W	340W	340W
	Resistance value	40Ω	25Ω	20Ω	30Ω
MDS-D-SPJ3-075NA	---	○	○		
MDS-D-SPJ3-22NA	---	○	○	○	○
MDS-D-SPJ3-37NA	---		○	○	○
MDS-D-SPJ3-55NA	---			○	
MDS-D-SPJ3-75NA	---				
MDS-D-SPJ3-110NA	---				

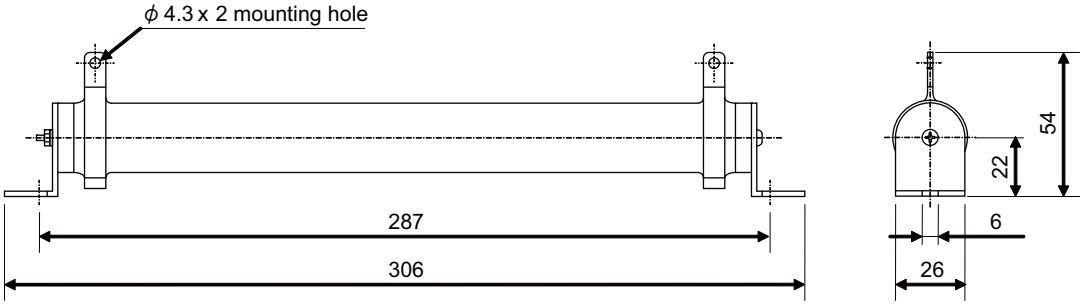
Corresponding spindle drive unit		External option regenerative resistor						
		R-UNIT1	R-UNIT2	R-UNIT3	R-UNIT4	R-UNIT5	FCUA-RB55 2 units connected in parallel	FCUA-RB75/2 2 units connected in parallel
	Parameter setting value	2800h	2900h	2A00h	2B00h	2C00h	2E00h	2D00h
	Regenerative capacity	700W	700W	2100W	2100W	3100W	680W	680W
	Resistance value	30Ω	15Ω	15Ω	10Ω	10Ω	10Ω	15Ω
MDS-D-SPJ3-075NA	---							
MDS-D-SPJ3-22NA	---	○	○	○				○
MDS-D-SPJ3-37NA	---	○	○	○	○	○	○	○
MDS-D-SPJ3-55NA	---		○	○	○	○	○	○
MDS-D-SPJ3-75NA	---		○	○	○	○	○	○
MDS-D-SPJ3-110NA	---				○	○		

⚠CAUTION Only the designated combination can be used for the external option regenerative resistor and drive unit.
There is a risk of fire, so always use the designated combination.

(3) External option regenerative resistor

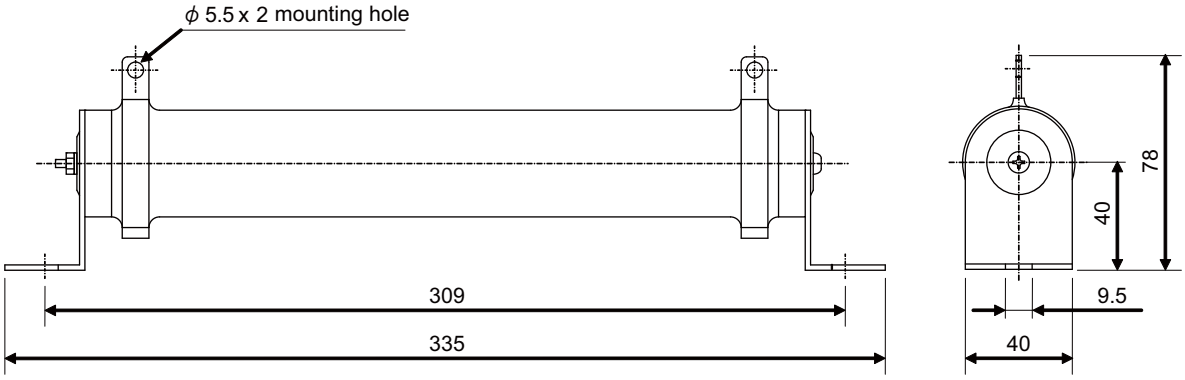
< GZG200W39OHMK, GZG200W120OHMK >

[Unit: mm]



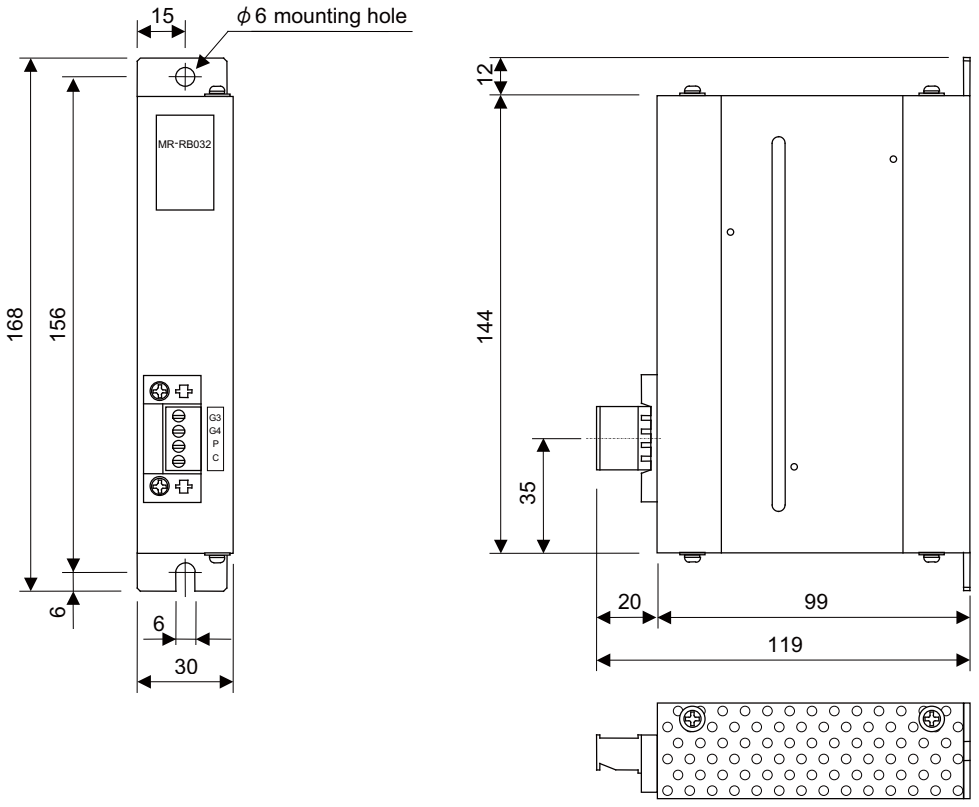
< GZG300W39OHMK >

[Unit: mm]



(4) External option regenerative resistor unit < MR-RB032 >

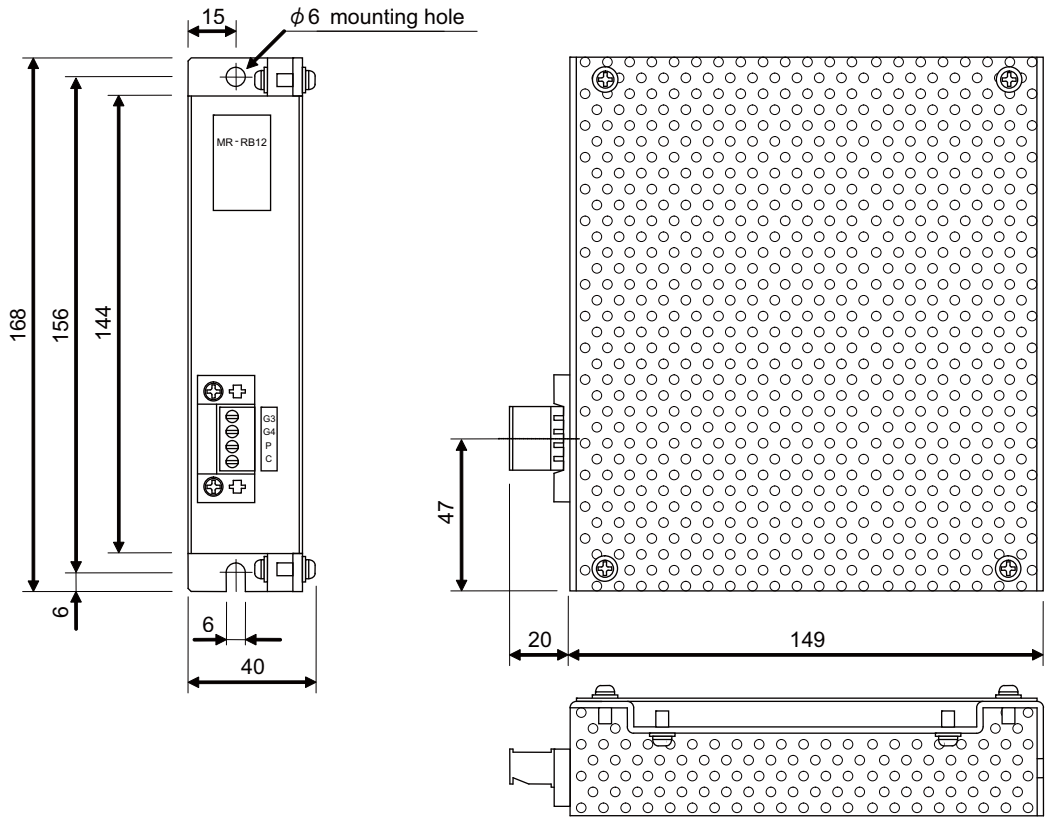
[Unit: mm]



Type	Regenerative capacity (W)	Resistance value (Ω)	Mass (kg)
MR-RB032	30	40	0.5

< MR-RB12 >

[Unit: mm]

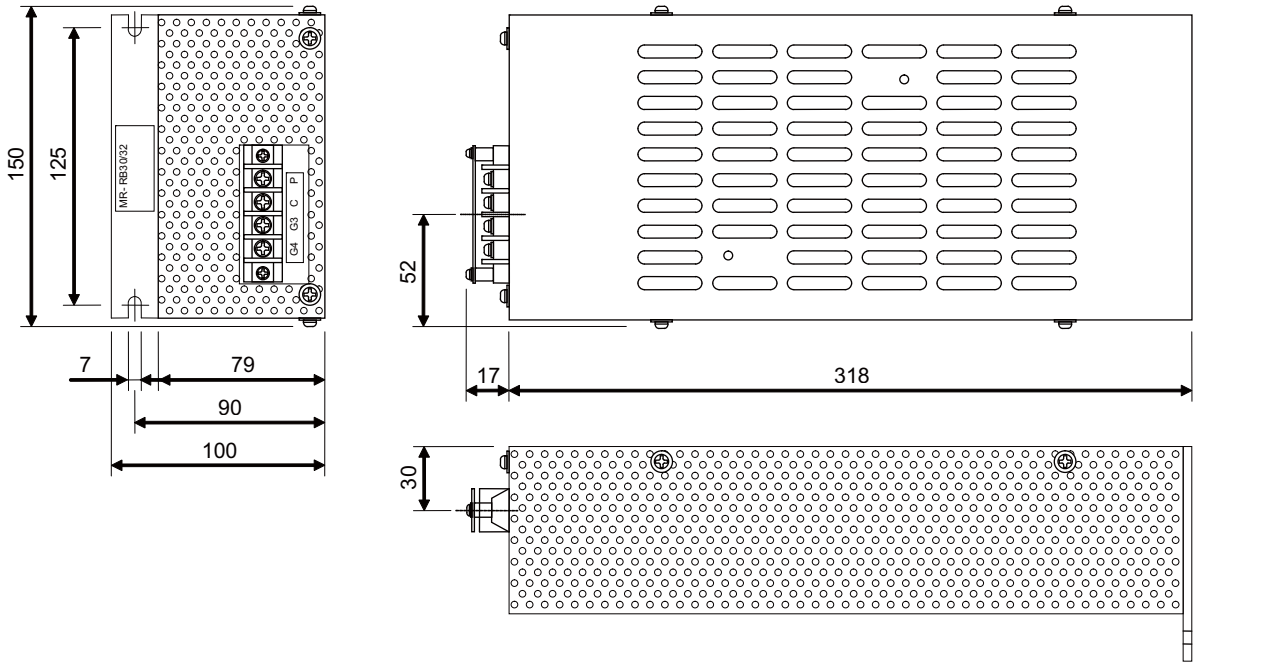


Type	Regenerative capacity (W)	Resistance value (Ω)	Mass (kg)
MR-RB12	100	40	0.8

5 Dedicated Options

< MR-RB32, MR-RB30, MR-RB31 >

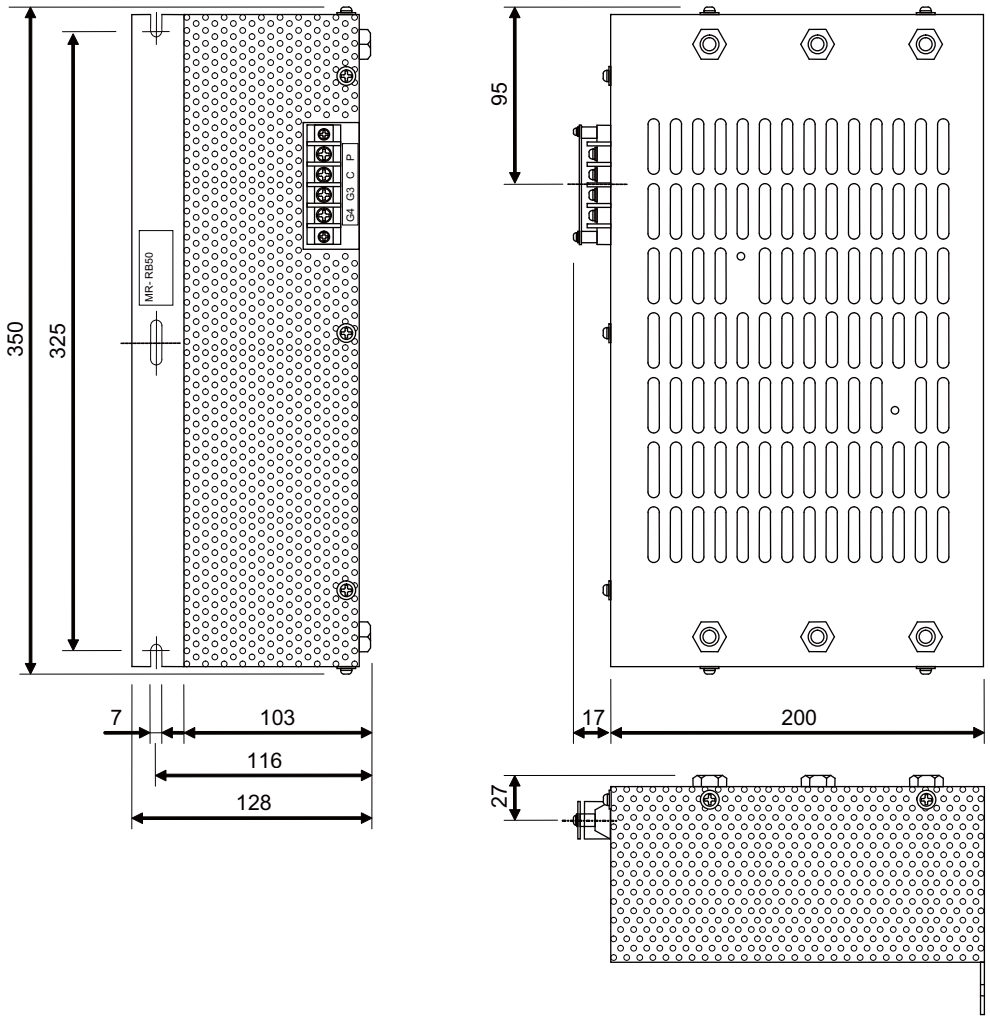
[Unit: mm]



Type	Regenerative capacity (W)	Resistance value (Ω)	Mass (kg)
MR-RB32	300	40	2.9
MR-RB30	300	13	2.9
MR-RB31	300	6.7	2.9

< MR-RB50, MR-RB51 >

[Unit: mm]

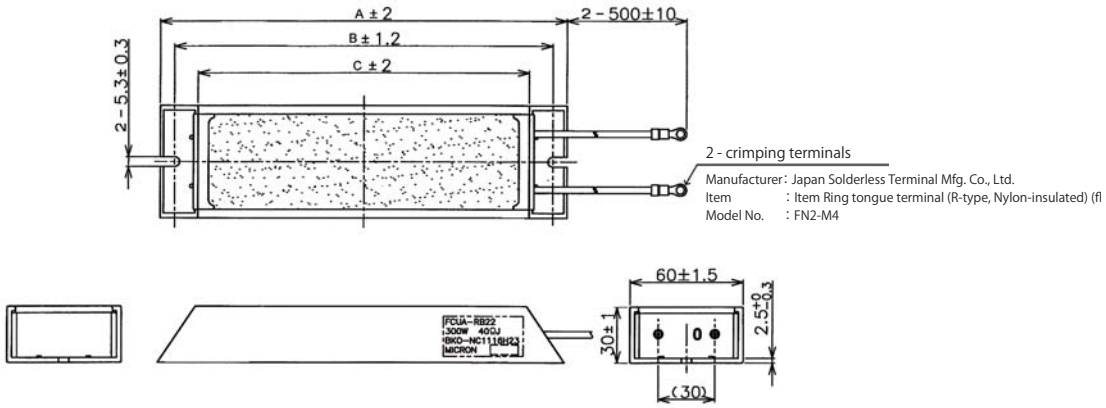


Type	Regenerative capacity (W)	Resistance value (Ω)	Mass (kg)
MR-RB50	500	13	5.6
MR-RB51	500	6.7	5.6

5 Dedicated Options

< FCUA-RB22, FCUA-RB37 >

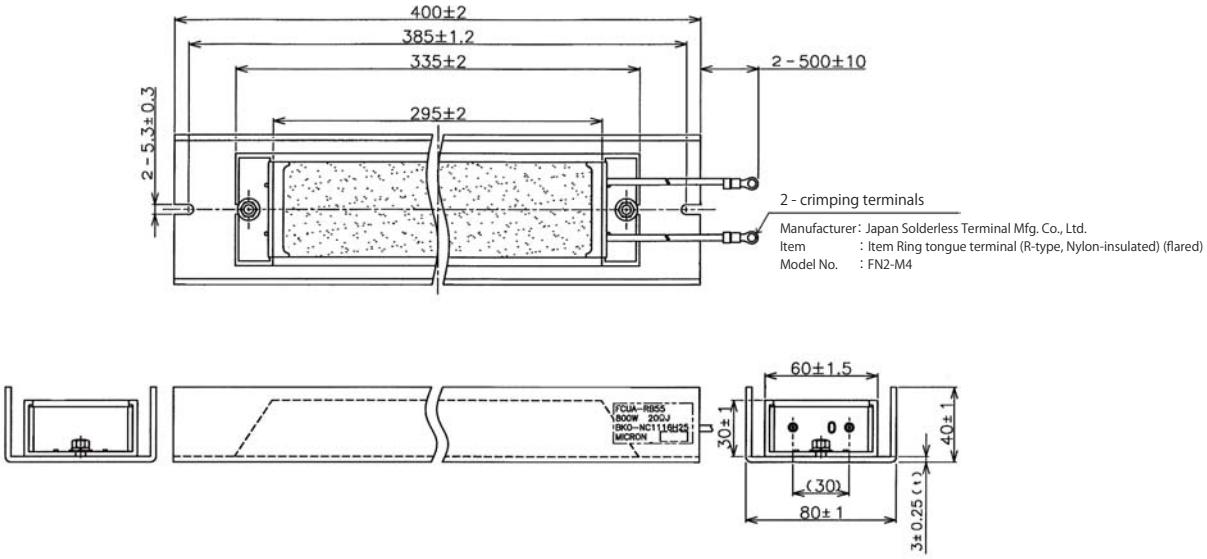
[Unit: mm]



Type	Regenerative capacity (W)	Outline dimension (mm)			Resistance value (Ω)	Mass (kg)
		A	B	C		
FCUA-RB22	155	215	200	175	40	0.8
FCUA-RB37	185	335	320	295	25	1.2

< FCUA-RB55, FCUA-RB75/2>

[Unit: mm]



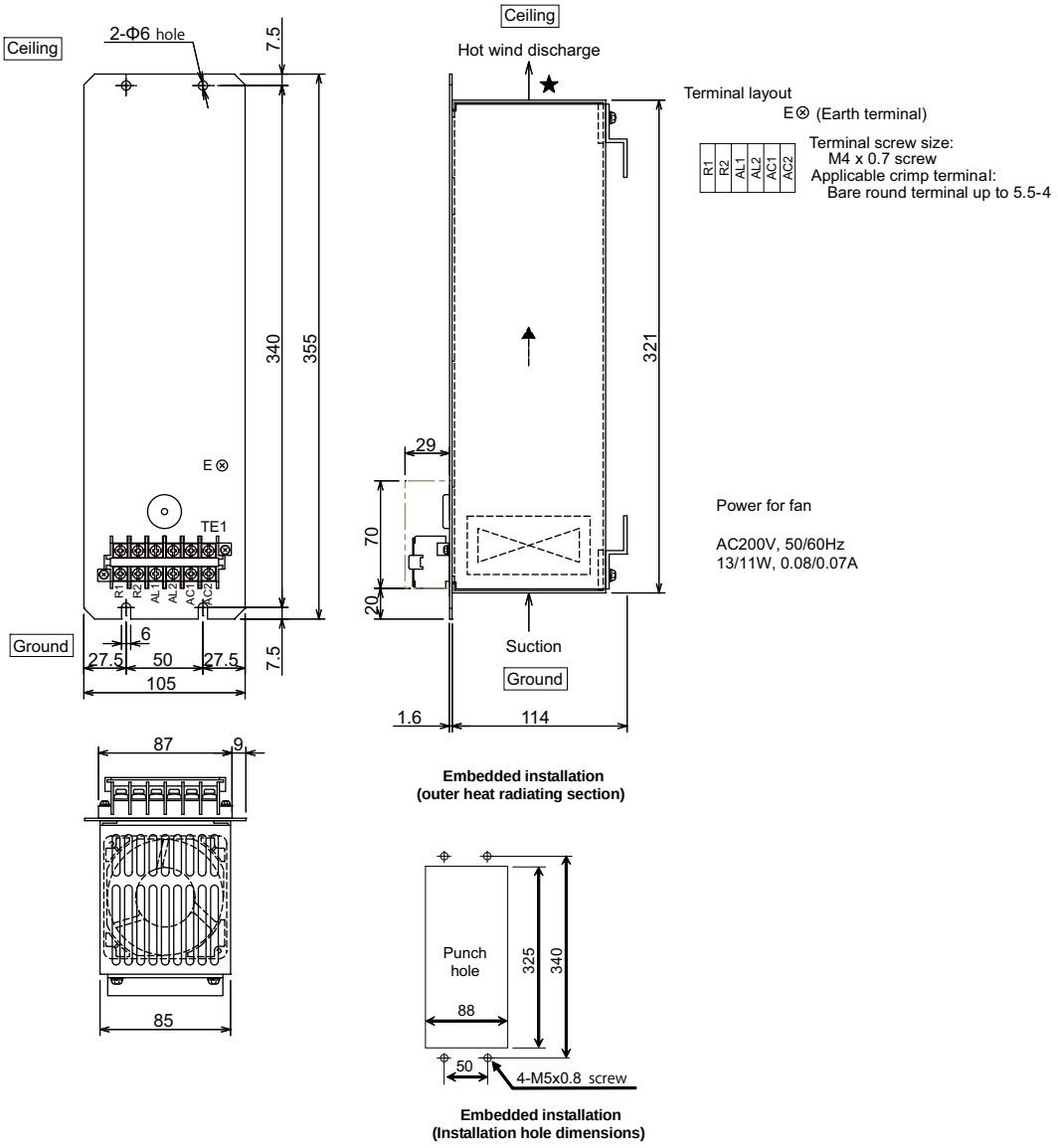
Type	Regenerative capacity (W)	Resistance value (Ω)	Mass (kg)
FCUA-RB55	340	20	2.2
FCUA-RB75/2 (2 units connected in parallel)	680	15	2.2

⚠ CAUTION

1. When using an operation pattern in which the regenerative resistor is used at a high frequency, the surface of the resistor may exceed 300°C, so take care to the installation and the heat radiation. Do not install the resistor in a place where it can be easily touched by hand or body parts as touching could lead to burns. Install a well-ventilated protective cover (punched metal, etc.) if body parts might come in contact.
2. Installation of the regenerative resistor on a metallic surface outside the panel is recommended to improve the heat radiating effect.
3. Install the regenerative resistor so that the section where the lead wires are led out is not at the top of the resistor.

< R-UNIT-1, -2 >

[Unit: mm]



Type	Regenerative capacity (W)	Resistance value (Ω)	Mass (kg)
R-UNIT-1	700	30	4.3
R-UNIT-2	700	15	4.4

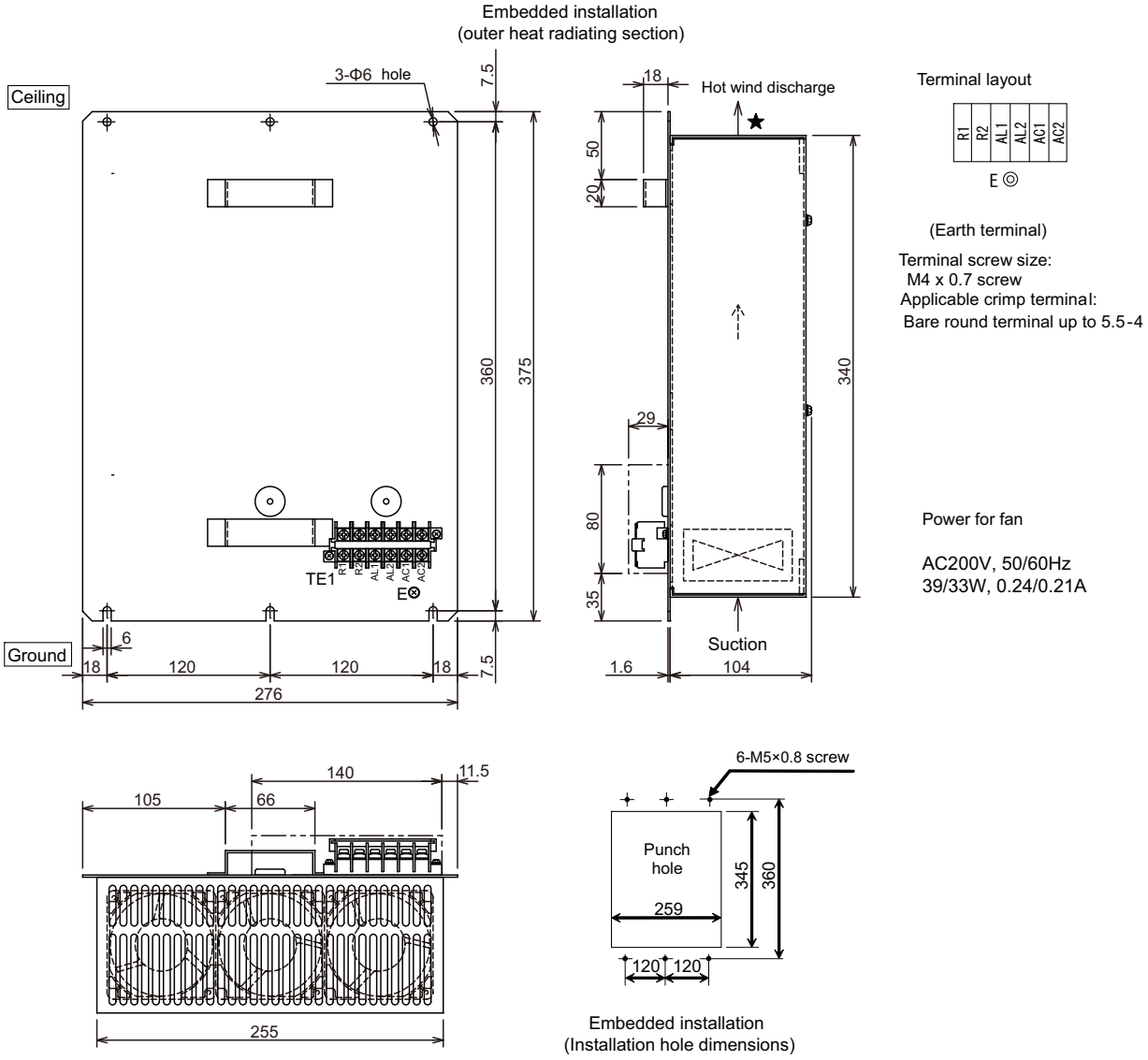
⚠ CAUTION

1. Do not wire or arrange other devices in front of the section marked with a ★ as extremely hot wind will be blown out.
2. For the installation direction of this resistor, the "Ceiling" is the top and "Ground" is the bottom.
3. Touching the resistor when it is hot could lead to burns. Always install a protective cover or consider the installation site so that workers will not touch the unit.
4. The resistor's heating value will differ according to the acceleration/deceleration frequency, speed being used and the load GD^2 conditions, etc. However, install the resistor so that the hot wind is always exhausted to outside the panel.

5 Dedicated Options

< R-UNIT-3, -4 >

[Unit: mm]



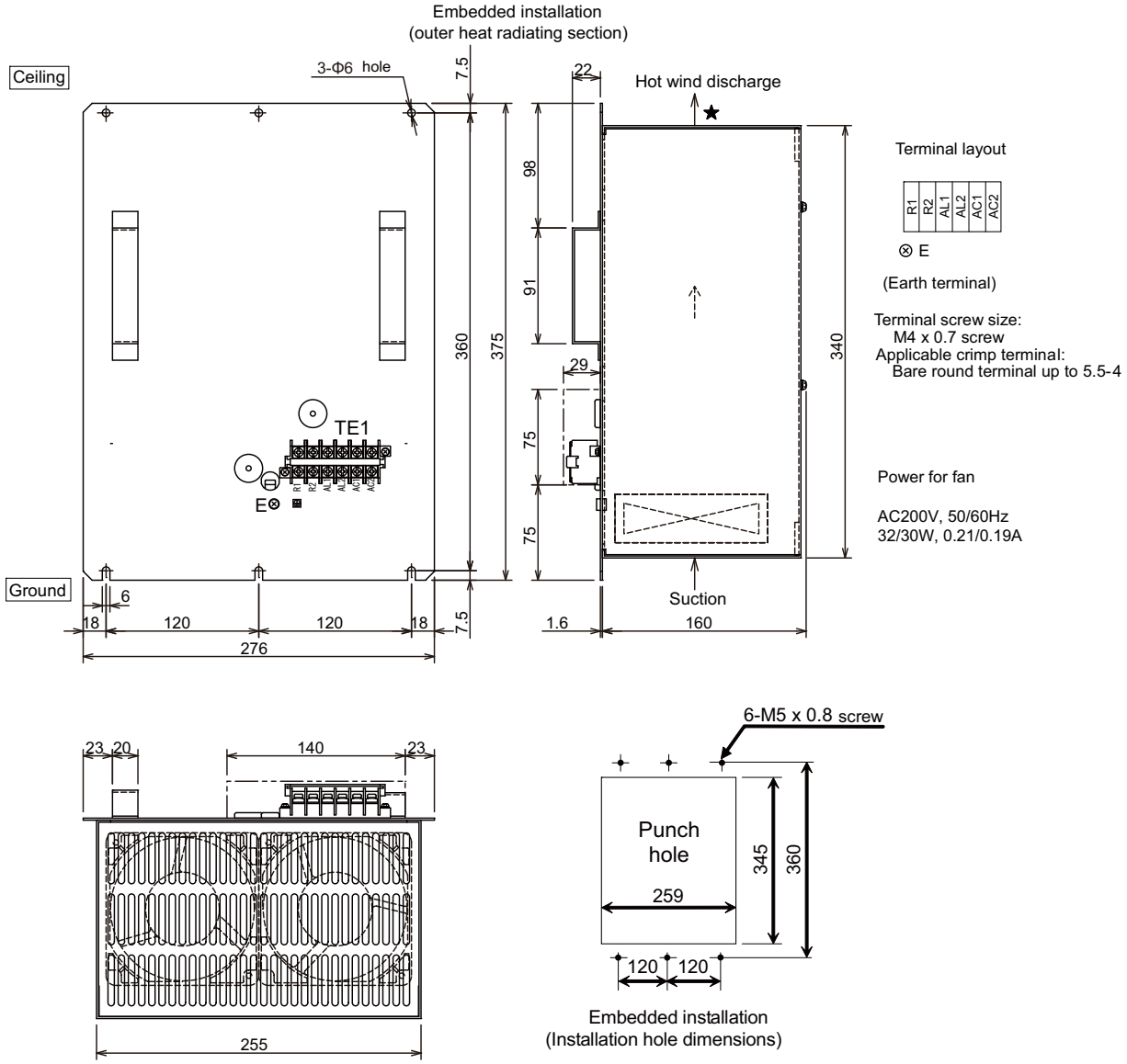
Type	Regenerative capacity (W)	Resistance value (Ω)	Mass (kg)
R-UNIT-3	2100	15	10.8
R-UNIT-4	2100	10	11.0

⚠ CAUTION

1. Attach packing to the flange section.
2. Do not wire or arrange other devices in front of the section marked with a ★ as extremely hot wind will be blown out.
3. For the installation direction of this resistor, the "Ceiling" is the top and "Ground" is the bottom.
4. Touching the resistor when it is hot could lead to burns. Always install a protective cover or consider the installation site so that workers will not touch the unit.
5. The resistor's heating value will differ according to the acceleration/deceleration frequency, speed being used and the load GD^2 conditions, etc. However, install the resistor so that the hot wind is always exhausted to outside the panel.

< R-UNIT-5 >

[Unit: mm]



Type	Regenerative capacity (W)	Resistance value (Ω)	Mass (kg)
R-UNIT-5	3100	10	15.0

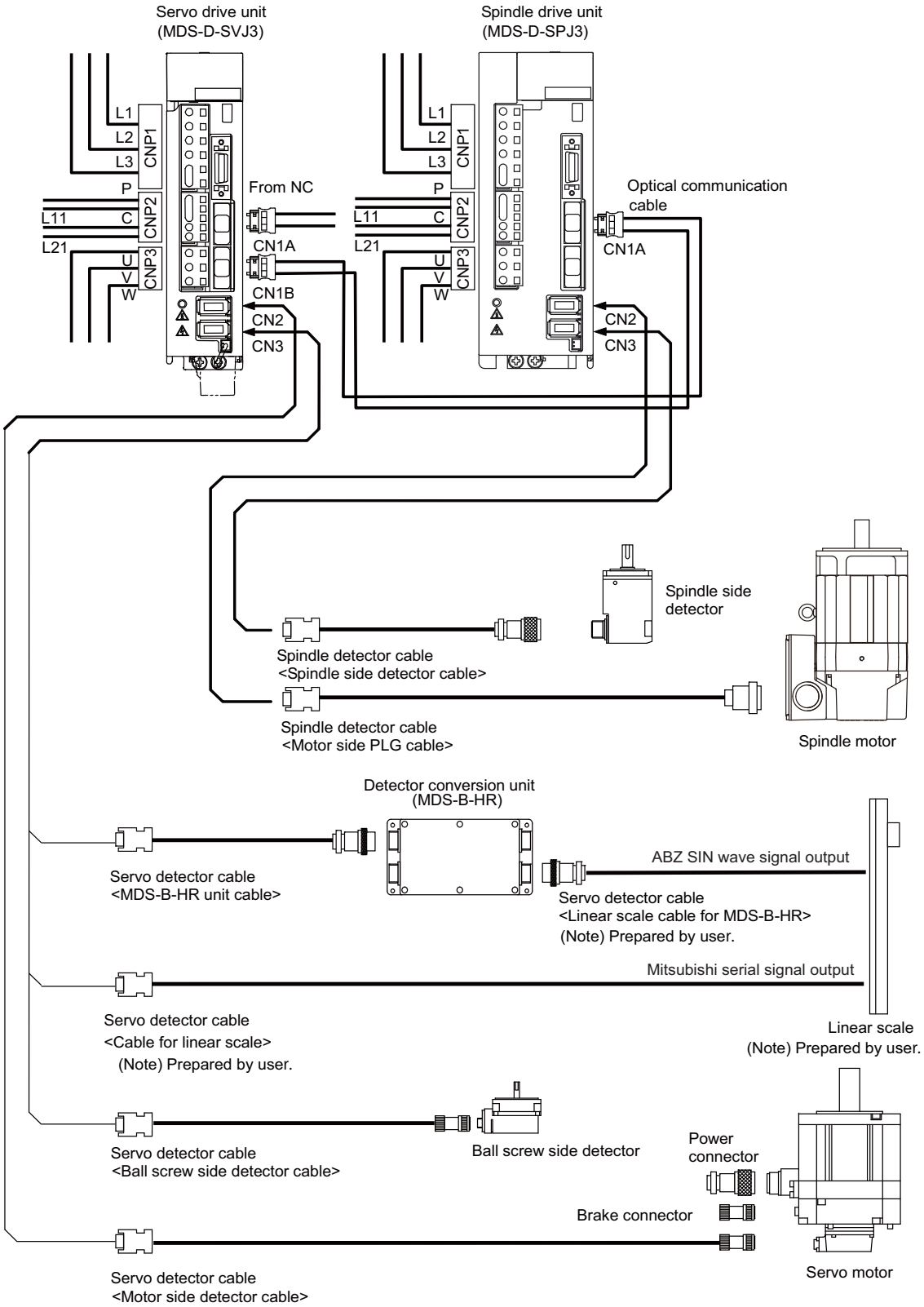
⚠ CAUTION

2. Attach packing to the flange section.
3. Do not wire or arrange other devices in front of the section marked with a ★ as extremely hot wind will be blown out.
4. For the installation direction of this resistor, the "Ceiling" is the top and "Ground" is the bottom.
5. Touching the resistor when it is hot could lead to burns. Always install a protective cover or consider the installation site so that workers will not touch the unit.
6. The resistor's heating value will differ according to the acceleration/deceleration frequency, speed being used and the load GD^2 conditions, etc. However, install the resistor so that the hot wind is always exhausted to outside the panel.

5-5 Cables and connectors

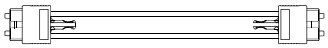
5-5-1 Cable connection diagram

The cables and connectors that can be ordered from Mitsubishi Electric Corp. as option parts are shown below. Cables can only be ordered in the designated lengths. Purchase a connector set, etc., to create special length cables.



5-5-2 List of cables and connectors

< Optical communication cable>

Item		Model	Contents	
For CN1A/ CN1B	Optical communication cable For wiring between drive units (inside panel)	G396-L□M □: Length 0.3, 0.5, 1, 2, 3, 5m	Drive unit side connector (Japan Aviation Electronics Industry) Connector: 2F-2D103	Drive unit side connector (Japan Aviation Electronics Industry) Connector: 2F-2D103
				
For CN1A/ CN1B	Optical communication cable For wiring between drive units (outside panel) For optical servo communication repeater unit	G380-L□M □: Length 5, 10, 12, 15, 20, 25, 30m	Drive unit side connector (Tyco Electronics) Connector: 1123445-1	Drive unit side connector (Tyco Electronics) Connector: 1123445-1
				

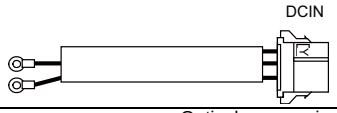
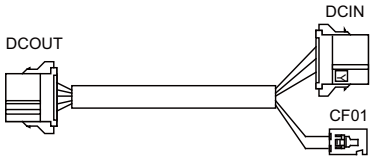
(Note1) For details on the optical communication cable, refer to the section "Optical communication cable specification".

(Note2) For details on the optical communication cable for wiring between NC and drive unit, refer to the instruction manual for CNC.

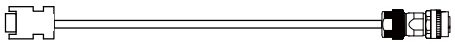
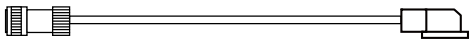
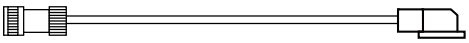
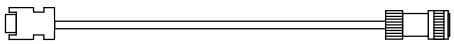
<Battery cable and connector>

Item		Model	Contents	
For battery unit	Battery cable (For drive unit -Battery box) *The battery box side is connected using a bare conductor or a terminal bar.	DG23-□M □: Length 0.3, 0.5, 1, 2, 3, 5, 7, 10m	Drive unit side connector (Hirose Electric) Connector: DF1B-2S-2.5R Contact: DF1B-2428SCA	Battery box side
				
	Battery cable (For drive unit -Battery box) *The battery box side is connected using a bare conductor or a terminal bar.	DG25-□M □: Length 0.3, 0.5, 1, 2, 3, 5, 7, 10m	Drive unit side connector (Hirose Electric) Connector: DF3-2S-2C Contact: DF3-2428SCC	Battery box side
				
	5V supply/DO output cable (For drive unit -Battery box) *The battery box side is connected using a bare conductor or a terminal bar.	DG24-□M □: Length 0.3, 0.5, 1, 2, 3, 5, 7, 10m	Drive unit side connector (3M) Connector: 10120-6000EL Contact: 10320-3210-000	Battery box side
				
For drive unit	Battery cable (For drive unit - drive unit) *This cable is required to supply the power from the battery unit to multiple drive units.	DG22-□M □: Length 0.3, 0.5, 1, 2, 3, 5, 7, 10m	Drive unit side connector (Hirose Electric) Connector: DF1B-2S-2.5R Contact: DF1B-2428SCA	Drive unit side connector (Hirose Electric) Connector: DF1B-2S-2.5R Contact: DF1B-2428SCA
				

< Optical communication repeater unit >

Item		Model	Contents
For OPT1/2	Optical communication cable For wiring between drive unit and optical communication repeater unit/ For wiring between optical communication repeater units	G380-L□M □ : Length 5, 10, 12, 15, 20, 25, 30m	Drive unit side/ Optical communication repeater unit side connector (Tyco Electronics) Connector: 1123445-1 Optical communication repeater unit side connector (Tyco Electronics) Connector: 1123445-1 
For DCIN	For optical communication repeater unit DC24V power cable	F070 □ : Length 0.5, 1.5, 3, 5, 8, 10, 15, 20m	DC24V power side terminal (J.S.T.) Crimp terminal: V1.25-3 or V1.25-4 × 2 Optical communication repeater unit side connector (Tyco Electronics) Connector: 2-178288-3 Contact: 1-175218-5 × 3 
For DCIN/ ACFAIL	For optical communication repeater unit/ For connecting Mitsubishi power unit PD25,PD27 DC24V power cable (power OFF detection)	F110 □ : Length 0.5, 1.5, 3, 5, 8, 10, 15m	DC24V power side connector (Tyco Electronics) Connector: 3-178127-6 Contact: 1-175218-5 (for AWG16) × 3 1-175217-5 (for AWG22) × 2 Optical communication repeater unit side connector <DCIN> (Tyco Electronics) Connector: 2-178288-3 Contact: 1-175218-5 × 3 <ACFAIL (CF01)> (MOLEX) 51030-0230 50084-8160 × 2 

< Servo / tool spindle detector cable and connector >

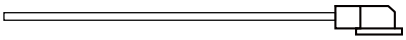
Item			Model	Contents
For CN2/3	For HF/ For HF-KP (Tool spindle) Motor side detector cable Ball screw side detector cable		CNV2E-8P-□M □: Length 2, 3, 4, 5, 7, 10, 15, 20, 25, 30m	Drive unit side connector (3M) Receptacle : 36210-0100PL Shell kit : 36310-3200-008 (MOLEX) Connector set: 54599-1019 Motor detector/ Ball screw side detector side connector (DDK) Plug : CM10-SP10S-M(D6) Contact : CM10-#22SC(S1)(D8) 
			CNE10-CVS	Reinforcing cover for straight plug CM10-SP-CV (DDK) 
			CNV2E-9P-□M □: Length 2, 3, 4, 5, 7, 10, 15, 20, 25, 30m	Drive unit side connector (3M) Receptacle : 36210-0100PL Shell kit : 36310-3200-008 (MOLEX) Connector set: 54599-1019 Motor detector/ Ball screw side detector side connector (DDK) Plug : CM10-AP10S-M(D6) Contact : CM10-#22SC(S1)(D8) 
			CNE10-CVL	Reinforcing cover for angle plug CM10-AP-D-CV (DDK) 
	Direct connection type	For HF-KP (Servo) Motor side detector cable	CNV2E-K1P-□M Lead out in direction of motor shaft □: Length 2, 3, 5, 7, 10,m Compatible with only IP65	Drive unit side connector (3M) Receptacle : 36210-0100PL Shell kit : 36310-3200-008 (MOLEX) Connector set: 54599-1019 Motor detector/ Ball screw side detector side connector (Tyco Electronics) Connector: 1674320-1 
			CNV2E-K2P-□M Lead out in opposite direction of motor shaft □: Length 2, 3, 5, 7, 10,m Compatible with only IP65	Drive unit side connector (3M) Receptacle : 36210-0100PL Shell kit : 36310-3200-008 (MOLEX) Connector set: 54599-1019 Motor detector/ Ball screw side detector side connector (Tyco Electronics) Connector: 1674320-1 
	Relay type (Note)	For HF-KP (Servo) Motor side detector relay cable (motor side)	CNV22J-K1P-0.3M Lead out in direction of motor shaft Length: 0.3m Compatible with only IP65	Drive unit side connector (DDK) Plug: CM10-CR10P-M Motor detector/ Ball screw side detector side connector (Tyco Electronics) Plug : 1747464-1 Contact: 1674335-4 
			CNV22J-K2P-0.3M Lead out in opposite direction of motor shaft Length: 0.3m Compatible with only IP65	Drive unit side connector (DDK) Plug: CM10-CR10P-M Motor detector/ Ball screw side detector side connector (Tyco Electronics) Plug : 1747464-1 Contact: 1674335-4 
		For HF-KP (Servo) Motor side detector relay cable (Drive unit side)	CNV2E-8P-□M □: Length 2, 3, 4, 5, 7, 10, 15, 20, 25, 30m	Servo drive unit side connector (3M) Receptacle : 36210-0100JL Shell kit : 36310-3200-008 Servomotor detector/ Ball screw side detector side connector (DDK) Plug : CM10-SP10S-M Contact: CM10-#22SC 

(Note) When using cable of 15m or longer, use relay cable.

5 Dedicated Options

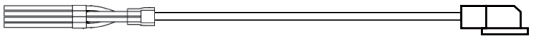
Item		Model	Contents
For motor detector/ Ball screw side detector	Motor side detector connector/ Ball screw side detector connector	CNE10-R10S(9) Applicable cable outline ø6.0 to 9.0mm	Motor detector/ Ball screw side detector side connector (DDK) Plug : CM10-SP10S-M(D6) Contact : CM10-#22SC(S1)(D8) 
		CNE10-CVS	Reinforcing cover for straight plug CM10-SP-CV (DDK) 
		CNE10-R10L(9) Applicable cable outline ø6.0 to 9.0mm	Motor detector/ Ball screw side detector side connector (DDK) Plug : CM10-AP10S-M(D6) Contact : CM10-#22SC(S1)(D8) 
		CNE10-CVL	Reinforcing cover for angle plug CM10-AP-D-CV (DDK) 
CN3	MDS-B-HR unit cable	CNV2E-HP-□M □: Length 2, 3, 4, 5, 7, 10, 15, 20, 25, 30m	Drive unit side connector (3M) Receptacle: 36210-0100PL Shell kit : 36310-3200-008 (MOLEX) Connector set: 54599-1019 MDS-B-HR unit side connector (Hirose Electric) Plug : RM15WTP-8S Clamp : RM15WTP-CP (10) 
For MDS-B-HR unit	MDS-B-HR connector (For CON1,2: 1) (For CON3: 1)	CNEHRS(10) Applicable cable outline ø8.5 to 11mm	MDS-B-HR unit side connector (Hirose Electric) Plug : RM15WTP-8S (for CON1, 2) RM15WTP-12P (for CON3) Clamp : RM15WTP-CP (10) 
For CN2/3	Detector connector	CNU2S(AWG18)	Drive unit side connector (3M) Receptacle: 36210-0100PL Shell kit : 36310-3200-008 (MOLEX) Connector set: 54599-1019 

< Brake cable and connector >

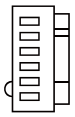
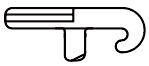
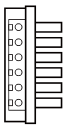
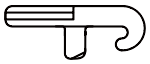
Item		Model	Contents
For motor brake	Brake connector for HF	CNB10-R2S(6) Applicable cable outline ø4.0 to 6.0mm	Servomotor side brake connector (DDK) Plug : CM10-SP2S-S(D6) Contact : CM10-#22SC(S2)(D8) 
		CNE10-CVS	Reinforcing cover for straight plug CM10-SP-CV (DDK) 
		CNB10-R2L(6) Applicable cable outline ø4.0 to 6.0mm	Servomotor side brake connector (DDK) Plug : CM10-AP2S-S(D6) Contact : CM10-#22SC(S2)(D8) 
		CNE10-CVL	Reinforcing cover for angle plug CM10-AP-D-CV (DDK) 
	Brake cable for HF-KP	MR-BKS1CBL□M-A1-H Lead out in direction of motor shaft □: Length 2, 3, 5, 7, 10m	Servomotor side brake connector (Japan Aviation Electronics Industry) Plug : JN4FT02SJ1-R Contact : ST-TMH-S-C1B-100-(A534G) 
		MR-BKS1CBL□M-A2-H Lead out in opposite direction of motor shaft □: Length 2, 3, 5, 7, 10m	Servomotor side brake connector (Japan Aviation Electronics Industry) Plug : JN4FT02SJ1-R Contact : ST-TMH-S-C1B-100-(A534G) 

5 Dedicated Options

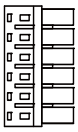
< Power connector >

Item		Model	Contents
For motor power	Power connector for HF75, 105, 54,104,154, 224, 123, 223, 142	CNP18-10S(14) Applicable cable outline ø10.5 to 14mm	Motor side power connector (DDK) Plug: CE05-6A18-10SD-C-BSS Clamp: CE3057-10A-1 (D240) 
		CNP18-10L(14) Applicable cable outline ø10.5 to 14mm	Motor side power connector (DDK) Plug: CE05-8A18-10SD-C-BAS Clamp: CE3057-10A-1 (D240) 
	Power connector for HF204,354,303, 302	CNP22-22S(16) Applicable cable outline ø12.5 to 16mm	Motor side power connector (DDK) Plug: CE05-6A22-22SD-C-BSS Clamp: CE3057-12A-1 (D240) 
		CNP22-22L(16) Applicable cable outline ø12.5 to 16mm	Motor side power connector (DDK) Plug: CE05-8A22-22SD-C-BAS Clamp: CE3057-12A-1 (D240) 
	Power cable for HF-KP	MR-PWS1CBL□M-A1-H Lead out in direction of motor shaft □: Length 2, 3, 5, 7, 10m	Motor side power connector (Japan Aviation Electronics Industry) Plug: JN4FT04SJ1-R Contact: ST-TMH-S-C1B-100-(A534G) 
		MR-PWS1CBL□M-A2-H Lead out in opposite direction of motor shaft □: Length 2, 3, 5, 7, 10m	Motor side power connector (Japan Aviation Electronics Industry) Plug: JN4FT04SJ1-R Contact: ST-TMH-S-C1B-100-(A534G) 

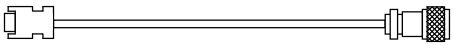
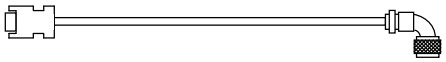
<Drive unit side main circuit connector>

Item		Model	Contents
For drive unit	For MDS-D-SVJ3-03NA,04NA,07NA For MDS-D-SPJ3-075NA	These connectors are supplied for each drive unit. Applicable cable size: 0.14mm^2 to 2.5mm^{2}Cable finish outside diameter: to φ3.8mm	For CNP1 (For power supply) 54928-0670(MOLEX) 
			For CNP2 (For control power) 54927-0520(MOLEX) 
			For CNP3 (For motor power) 54928-0370(MOLEX) 
			Connection lever 54932-0000(MOLEX) 
	For MDS-D-SVJ3-35NA For MDS-D-SPJ3-37NA	These connectors are supplied for each drive unit. Applicable cable size: 0.2mm^2 to 5.5mm^{2}Cable finish outside diameter: to φ5.0mm	For CNP1 (For power supply) PC4/6-STF-7.62-CRWH (Phoenix contact) 
			For CNP2 (For control power) 54927-0520(MOLEX) 
			For CNP3 (For motor power) PC4/3-STF-7.62-CRWH (Phoenix contact) 
			Connection lever 54932-0000(MOLEX) 

5 Dedicated Options

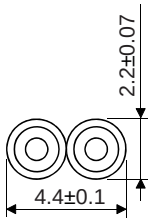
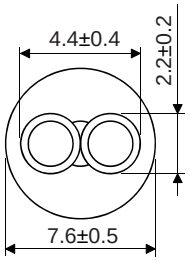
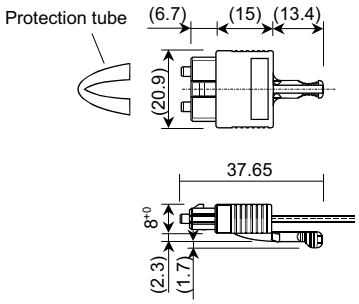
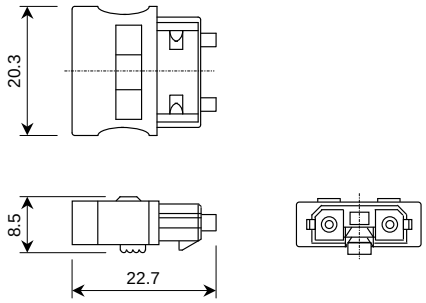
Item		Model	Contents
For drive unit	For MDS-D-SVJ3-10NA,20NA For MDS-D-SPJ3-22NA	These connectors are supplied for each drive unit. Applicable cable size: 0.2mm^2 to 5.5mm^{2}Cable finish outside diameter: to φ5.0mm	For CNP1 (For power supply) 06JFAT-SAXGFS-XL (J.S.T.) 
			For CNP2 (For control power) 05JFAT-SAXGSA-E-SS (J.S.T.) 
			For CNP3 (For motor power)) 03JFAT-SAXGFS-XL (J.S.T.) 

< Spindle detector cable and connector >

Item		Model	Contents	
For CN2	Motor side PLG cable Spindle side accuracy detector TS5690 cable	CNP2E-1-□M □: Length 2, 3, 4, 5, 7, 10, 15, 20, 25, 30m	Spindle drive unit side connector (3M) Receptacle: 36210-0100PL Shell kit : 36310-3200-008 (MOLEX) Connector set: 54599-1019	Spindle motor side connector (Tyco Electronics) Connector: 172169-1 Contact:170363-1(AWG26-22) 170364-1(AWG22-18)
				
For CN3	Spindle side detector OSE-1024 cable	CNP3EZ-2P-□M □: Length 2, 3, 4, 5, 7, 10, 15, 20, 25, 30m	Spindle drive unit side connector (3M) Receptacle : 36210-0100PL Shell kit : 36310-3200-008 (MOLEX) Connector set: 54599-1019	Spindle motor side connector (DDK) Connector: MS3106A20-29S(D190) Straight back shell: CE02-20BS-S Clamp: CE3057-12A-3
				
		CNP3EZ-3P-□M □: Length 2, 3, 4, 5, 7, 10, 15, 20, 25, 30m	Spindle drive unit side connector (3M) Receptacle : 36210-0100PL Shell kit : 36310-3200-008 (MOLEX) Connector set: 54599-1019	Spindle motor side connector (DDK) Connector: MS3106A20-29S(D190) Angle back shell: CE-20BA-S Clamp : CE3057-12A-3
				
For spindle motor	Motor side PLG connector Spindle side accuracy detector TS5690 connector	CNEPGS		Spindle motor side connector (Tyco Electronics) Connector: 172169-1 Contact:170363-1(AWG26-22) 170364-1(AWG22-18)
				
For spindle motor	Spindle side detector OSE-1024 cable	Applicable cable outline ø6.8 to 10mm		Spindle motor side connector (DDK) Connector:MS3106A20-29S(D190) Straight back shell: CE02-20BS-S Clamp: CE3057-12A-3
				
		Applicable cable outline ø6.8 to 10mm		Spindle motor side connector (DDK) Connector:MS3106A20-29S(D190) Angle back shell: CE-20BA-S Clamp: CE3057-12A-3
				
For CN2/3	Spindle detector drive unit side connector	CNU2S(AWG18)	Spindle drive unit side connector (3M) Receptacle : 36210-0100PL Shell kit : 36310-3200-008 (MOLEX) Connector set : 54599-1019	
				

5-5-3 Optical communication cable specifications

(1) Specifications

Cable model		G396-L□M	G380-L□M
Specification application		For wiring inside panel	For wiring outside panel For long distance wiring
Cable length		0.3, 0.5, 1.0, 2.0, 3.0, 5.0m	5.0, 10, 12, 15, 20, 25, 30m
Optical communication cable	Minimum bend radius	25mm	Enforced covering cable: 50mm cord: 30mm
	Tension strength	140N	980N (Enforced covering cable)
	Temperature range for use (Note1)	-40 to 85°C	-20 to 70°C
	Ambient	Indoors (no direct sunlight) No solvent or oil	
	Cable appearance [mm]		
	Connector appearance [mm]		

(Note1) This temperature range for use is the value for optical cable (cord) only. Temperature condition for the connector is the same as that for drive unit.

(Note2) Do not see directly the light generated from CN1A/CN1B connector of drive unit or the end of cable. When the light gets into eye, you may feel something is wrong for eye.
(The light source of optical communication corresponds to class1 defined in JISC6802 or IEC60825-1.)

(2) Cautions for using optical communication cable

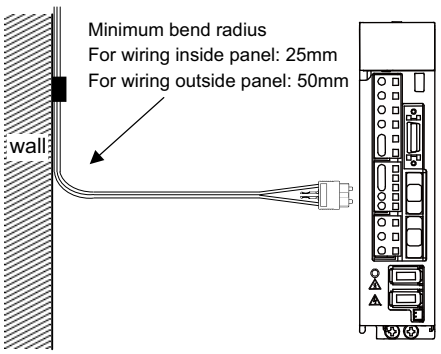
Optical communication cable is made from optical fiber. If optical fiber is added a power such as a major shock, lateral pressure, haul, sudden bending or twist, its inside distorts or breaks, and optical transmission will not be available. Especially, as optical fiber for G396-L□M is made of synthetic resin, it melts down if being left near the fire or high temperature. Therefore, do not make it touched the part, which becomes high temperature, such as radiator or regenerative brake option of drive unit.
Read described item in this section carefully and handle it with caution.

(a) Minimum bend radius

Make sure to lay the cable with greater radius than the minimum bend radius. Do not press the cable to edges of equipment or others. For the optical communication cable, the appropriate length should be selected with due consideration for the dimensions and arrangement of drive unit so that the cable bend will not become smaller than the minimum bend radius in cable laying. When closing the door of control box, pay careful attention for avoiding the case that optical communication cable is hold down by the door and the cable bend becomes smaller than the minimum bend radius.
Lay the cable so that the numbers of bends will be less than 10 times.

(b) Bundle fixing

When using optical communication cable of 3m or longer, fix the cable at the closest part to the connector with bundle material in order to prevent optical communication cable from putting its own weight on CN1A/CN1B connector of drive unit. Optical cord should be given loose slack to avoid from becoming smaller than the minimum bend radius, and it should not be twisted.
When tightening up the cable with nylon band, the sheath material should not be distorted. Fix the cable with tightening force of 1 to 2kg or less as a guide.



When laying cable, fix and hold it in position with using cushioning such as sponge or rubber which does not contain plasticizing material.
Never use vinyl tape for cord. Plasticizing material in vinyl tape goes into optical fiber and lowers the optical characteristic. At worst, it may cause wire breakage. If using adhesive tape for cable laying, the fire resistant acetate cloth adhesive tape 570F (Teraoka Seisakusho Co., Ltd) is recommended.
If laying with other wires, do not make the cable touched wires or cables made from material which contains plasticizing material.

(c) Tension

If tension is added on optical fiber, the increase of transmission loss occurs because of external force which concentrates on the fixing part of optical fiber or the connecting part of optical connector. At worst, the breakage of optical fiber or damage of optical connector may occur. For cable laying, handle without putting forced tension.

(d) Lateral pressure

If lateral pressure is added on optical communication cable, the optical cable itself distorts, internal optical fiber gets stressed, and then transmission loss will increase. At worst, the breakage of optical cable may occur. As the same condition also occurs at cable laying, do not tighten up optical communication cable with a thing such as nylon band (TY-RAP).
Do not trample it down or tuck it down with the door of control box or others.

(e) Twisting

If optical fiber is twisted, it will become the same stress added condition as when local lateral pressure or bend is added. Consequently, transmission loss increases, and the breakage of optical fiber may occur at worst.

(f) Cable selection

- When wiring is outside the power distribution panel or machine cabinet, there is a highly possibility that external power is added. Therefore, make sure to use the cable for wiring outside panel (G380-L□M)
- If a part of the wiring is moved, use the cable for wiring outside panel.
- In a place where sparks may fly and flame may be generated, use the cable for wiring outside panel.

(g) Method to lay cable

When laying the cable, do not haul the optical fiver or connector of the optical communication cable strongly. If strong force is added between the optical fiver and connector, it may lead to a poor connection.

(h) Protection when not in use

When the CN1A/CN1B connector of the drive unite or the optical communication cable connector is not used such as pulling out the optical communication cable from drive unit, protect the joint surface with attached cap or tube for edge protection. If the connector is left with its joint surface bared, it may lead to a poor connection caused by dirty.

(i) Attaching /Detaching optical communication cable connector

With holding the connector body, attach/detach the optical communication cable connector. If attaching/ detaching the optical communication cable with directly holding it, the cable may be pulled out, and it may cause a poor connection.
When pulling out the optical communication connector, pull out it after releasing the lock of clock lever.

(j) Cleaning

If CN1A and CN1B connector of the drive unit or optical communication cable connector is dirty, it may cause poor connection. If it becomes dirty, wipe with a bonded textile, etc. Do not use solvent such as alcohol.

(k) Disposal

When incinerating optical communication cable, hydrogen fluoride gas or hydrogen chloride gas which is corrosive and harmful may be generated. For disposal of optical communication cable, request for specialized industrial waste disposal services that has incineration facility for disposing hydrogen fluoride gas or hydrogen chloride gas.

(l) Return in troubles

When asking repair of drive unit for some troubles, make sure to put a cap on CN1A/CN1B connector. When the connector is not put a cap, the light device may be damaged at the transit. In this case, exchange and repair of light device is required.

6

Specifications of Peripheral Devices

Contents

6 Specifications of Peripheral Devices

6-1 Selection of wire

6-1-1 Example of wires by unit

Selected wires must be able to tolerate rated current of the unit's terminal to which the wire is connected.
How to calculate tolerable current of an insulated wire or cable is shown in "Tolerable current of electric cable" (1) of Japanese Cable Makers' Association Standard (JCS)-168-E (1995), its electric equipment technical standards or JEAC regulates tolerable current, etc. wire.
When exporting wires, select them according to the related standards of the country or area to export. In the UL standards, certification conditions are to use wires of 60°C and 75°C product. (UL508C)
Wire's tolerable current is different depending on conditions such as its material, structure, ambient temperature, etc. Check the tolerable current described in the specification of the wire to use.
Example of wire selections according to each standard is as follows.

(1) 600V vinyl insulated wire (IV wire) 60°C product (Example according to IEC/EN60204-1, UL508C)

Unit type	Terminal name	CNP1 (L1, L2, L3, ⏚)		CNP2 (L11, L21)		CNP3 (U, V, W, ⏚)		CNP2 (P,C)		Magnetic brake	
		mm^2	AWG	mm^2	AWG	mm^2	AWG	mm^2	AWG	mm^2	AWG
Spindle drive unit	MDS-D-SPJ3-075NA	2	14	2	14	2	14	2	14	---	---
	MDS-D-SPJ3-22NA	2	14			2	14				
	MDS-D-SPJ3-37NA	2	14			3.5	12				
	MDS-D-SPJ3-55NA	3.5	12			3.5	12				
	MDS-D-SPJ3-75NA	5.5	10			5.5	10	3.5	12		
	MDS-D-SPJ3-110NA	14	6			8	8				
Servo drive unit	MDS-D-SVJ3-03NA	2	14	2	14	2	14	2	14	2	14
	MDS-D-SVJ3-04NA	2	14			2	14				
	MDS-D-SVJ3-07NA	2	14			2	14				
	MDS-D-SVJ3-10NA	2	14			2	14				
	MDS-D-SVJ3-20NA	2	14			3.5	12				
	MDS-D-SVJ3-35NA	3.5	12			5.5	10				

(2) 600V double (heat proof) vinyl insulated wire (HIV wire) 75°C product (Example according to IEC/EN60204-1, UL508C)

Unit type	Terminal name	CNP1 (L1, L2, L3, ⏚)		CNP2 (L11, L21		CNP3 (U, V, W, ⏚)		CNP2 (P,C)		Magnetic brake	
		mm^2	AWG	mm^2	AWG	mm^2	AWG	mm^2	AWG	mm^2	AWG
Spindle drive unit	MDS-D-SPJ3-075NA	2	14	2	14	2	14	2	14	---	---
	MDS-D-SPJ3-22NA	2	14			2	14				
	MDS-D-SPJ3-37NA	2	14			3.5	12				
	MDS-D-SPJ3-55NA	3.5	12			3.5	12				
	MDS-D-SPJ3-75NA	5.5	10			5.5	10	3.5	12		
	MDS-D-SPJ3-110NA	8	8			8	8				
Servo drive unit	MDS-D-SVJ3-03NA	2	14	2	14	2	14	2	14	2	14
	MDS-D-SVJ3-04NA	2	14			2	14				
	MDS-D-SVJ3-07NA	2	14			2	14				
	MDS-D-SVJ3-10NA	2	14			2	14				
	MDS-D-SVJ3-20NA	2	14			2	14				
	MDS-D-SVJ3-35NA	2	14			5.5	10				

(3) 600V bridge polyethylene insulated wire (IC) 105 °C product (Example according to JEAC8001)

Unit type	Terminal name	CNP1 (L1, L2, L3, ⏚)		CNP2 (L11, L21)		CNP3 (U, V, W, ⏚)		CNP2 (P,C)		Magnetic brake	
		mm^2	AWG	mm^2	AWG	mm^2	AWG	mm^2	AWG	mm^2	AWG
Spindle drive unit	MDS-D-SPJ3-075NA	2	14	1.25	16	2	14	2	14	---	---
	MDS-D-SPJ3-22NA	2	14			2	14				
	MDS-D-SPJ3-37NA	2	14			2	14				
	MDS-D-SPJ3-55NA	2	14			3.5	12				
	MDS-D-SPJ3-75NA	3.5	12			3.5	10	3.5	12		
	MDS-D-SPJ3-110NA	5.5	10			5.5	10				
Servo drive unit	MDS-D-SVJ3-03NA	2	14	1.25	16	2	14	2	14	1.25	16
	MDS-D-SVJ3-04NA	2	14			2	14				
	MDS-D-SVJ3-07NA	2	14			2	14				
	MDS-D-SVJ3-10NA	2	14			2	14				
	MDS-D-SVJ3-20NA	2	14			2	14				
	MDS-D-SVJ3-35NA	2	14			3.5	12				

⚠ CAUTION

1. Selection conditions follow IEC/EN60204-1, UL508C, JEAC8001.
   - Ambient temperature is maximum 40°C.
   - Cable installed on walls without ducts or conduits.

   To use the wire under conditions other than above, check the standards you are supposed to follow.
2. The maximum wiring length to the motor is 30m.
   If the wiring distance between the drive unit and motor is 20m or longer, use a thick wire so that the cable voltage drop is 2% or less.
3. Always wire the grounding wire.

6-2 Selection of circuit protector and contactor

Always select the circuit protector and contactor properly, and install them to each drive unit to prevent disasters.

6-2-1 Selection of circuit protector

Calculate a circuit protector selection current from the rated output and the nominal input voltage of the drive unit as in the expression below. And then select the minimum capacity circuit protector whose rated current meets the circuit protector selection current.

Circuit protector selection current [A] =
(Circuit protector selection current for 200V input [A] / Nominal input voltage [V]) × 200 [V]

Selection of circuit protector for 200V input

Unit type MDS-D-SVJ3-	03NA	04NA	07NA	10NA	20NA	35NA
Rated output	0.3kW	0.4kW	0.75kW	1.0kW	2.0kW	3.5kW
Circuit protector selection current for 200V input	2.5A	5A	7A	8A	10A	15A
Selection example of circuit protector (Mitsubishi Electric Corp.)	NF30-SW3P-5A	NF30-SW3P-10A	NF30-SW3P-15A	NF30-SW3P-15A	NF30-SW3P-20A	NF30-SW3P-30A
Rated current of the selection example of circuit protector	5A	10A	15A	15A	20A	30A

Unit type MDS-D-SPJ3-	075NA	22NA	37NA	55NA	75NA	110NA
Rated output	0.75kW	2.2kW	3.7kW	5.5kW	7.5kW	11kW
Circuit protector selection current for 200V input	6A	9A	15A	23A	31A	45A
Selection example of circuit protector (Mitsubishi Electric Corp.)	NF30-SW3P-15A	NF30-SW3P-20A	NF30-SW3P-30A	NF50-SW3P-50A	NF100-SW3P-60A	NF100-SW3P-100A
Rated current of the selection example of circuit protector	15A	20A	30A	50A	60A	100A

Option part: A circuit protector is not prepared as an NC unit accessory, so purchase the part from your dealer, etc.

⚠ CAUTION

1. It is dangerous to share a circuit protector for multiple drive units, so do not share it. Always install the circuit protectors for each drive unit.
2. If the control power (L11, L21) must be protected, select according to the section "6-4-1 Circuit protector ".

6-2-2 Selection of contactor

Select the contactor selection current that is calculated from the rated output and the nominal input voltage of the drive unit as in the expression below. And then select the contactor whose conventional free-air thermal current meets the contactor selection current.

Contactor selection current [A]=
(Contactor selection current for 200V input [A] / Nominal input voltage [V]) × 200 [V]

Selection of contactor for 200V input

Unit type MDS-D-SVJ3-	03NA	04NA	07NA	10NA	20NA	35NA
Rated output	0.3kW	0.4kW	0.75kW	1.0kW	2.0kW	3.5kW
Contactor selection current for 200V input	2.5A	5A	7A	8A	10A	15A
Selection example of contactor (Mitsubishi Electric Corp.)	S-N12 -AC200V	S-N12 -AC200V	S-N12 -AC200V	S-N12 -AC200V	S-N18 -AC200V	S-N20 -AC200V
Conventional freeair thermal current of the selection example of contactor	20A	20A	20A	20A	25A	32A

Unit type MDS-D-SPJ3-	075NA	22NA	37NA	55NA	75NA	110NA
Rated output	0.75kW	2.2kW	3.7kW	5.5kW	7.5kW	11kW
Contactor selection current for 200V input	6A	9A	15A	23A	31A	45A
Selection example of contactor (Mitsubishi Electric Corp.)	S-N12- AC200V	S-N18- AC200V	S-N20- AC200V	S-N25- AC200V	S-N25- AC200V	S-N35- AC200V
Conventional freeair thermal current of the selection example of contactor	20A	25A	32A	50A	50A	60A

Option part: A contactor is not prepared as an NC unit accessory, so purchase the part from your dealer, etc.

POINT

1. Use an alternating contactor.
2. Select a contactor whose excitation coil does not operate at 15mA or less.

6-3 Selection of earth leakage breaker

When installing an earth leakage breaker, select the breaker on the following basis to prevent the breaker from malfunctioning by the higher frequency earth leakage current generated in the servo or spindle drive unit.

(1) Selection

Obtaining the earth leakage current for all drive units referring to the following table, select an earth leakage breaker within the "rated non-operation sensitivity current".
Usually use an earth leakage breaker for inverter products that function at a leakage current within the commercial frequency range (50 to 60Hz).
If a product sensitive to higher frequencies is used, the breaker could malfunction at a level less than the maximum earth leakage current value.

Earth leakage current for each drive unit

Unit	Earth leakage current	Maximum earth leakage current
MDS-D-SPJ3-075NA to 110NA	6mA	15mA
MDS-D-SVJ3-03NA to 35NA	1mA	2mA

(Note) Maximum earth leakage current: Value that considers wiring length and grounding, etc.(Commercial frequency 50/60Hz)

(2) Measurement of earth leakage current

When actually measuring the earth leakage current, use a product that is not easily affected by the higher frequency earth leakage current. The measurement range should be 50 to 60Hz.

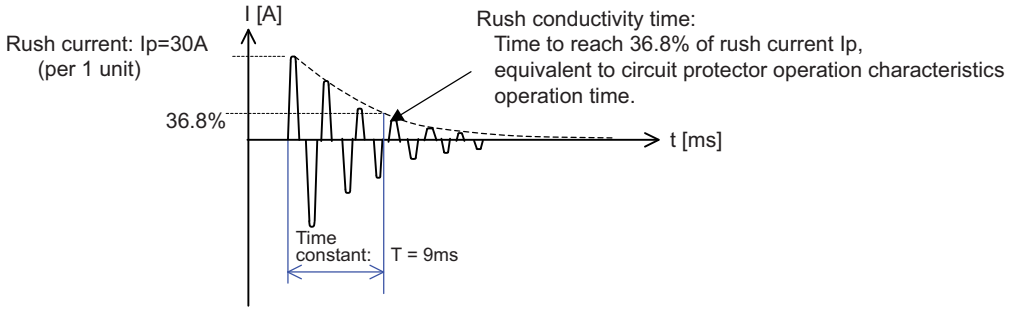
POINT

1. The earth leakage current tends to increase as the motor capacity increases.
2. A higher frequency earth leakage current will always be generated because the inverter circuit in the drive unit switches the transistor at high speed. Always ground to reduce the higher frequency earth leakage current as much as possible.
3. An earth leakage current containing higher frequency may reach approx. several hundreds of mA. According to IEC479-2, this level is not hazardous to the human body.

6-4 Branch-circuit protection (for control power supply)

6-4-1 Circuit protector

This breaker is used to switch the control power and to provide overload and short-circuit protection.
When connecting a circuit protector to the power input (L11 and L21) for the control circuit, use a product that does not trip (incorrectly activate) by a rush current when the power is turned ON. A circuit protector with inertial delay is available to prevent unnecessary tripping. Select the product to be used according to the machine specifications.
The rush current and rush conductivity time differ according to the power impedance and power ON timing, so select a product that does not trip even under the conditions listed in the following table.



POINT

When collectively protecting the control circuit power for multiple units, select a circuit protector that satisfies the total sum of the rush current Ip.
The largest value is used for the rush conductivity time T.

6-4-2 Fuse protection

The fuse of branch-circuit protection must use UL class CC, J or T. In the selection, please consider rush current and rush conductive time.

Selection of branch-circuit protection fuse

Connected total of unit	Fuse (Class CC)		Wire Size
	Rated [V]	Current [A]	AWG
1 - 4	600	20	16 to 14
5 - 8		35	

⚠ CAUTION

For continued protection against risk of fire, replace only with same type 600 V, 20 or 35 A (UL CLASS CC) fuse.

⚠ WARNING

Before replacing fuse, confirm all power controlling the drive system is shut-OFF. Be sure to look out the power source to prevent the power from being turned ON while maintenance is being performed.

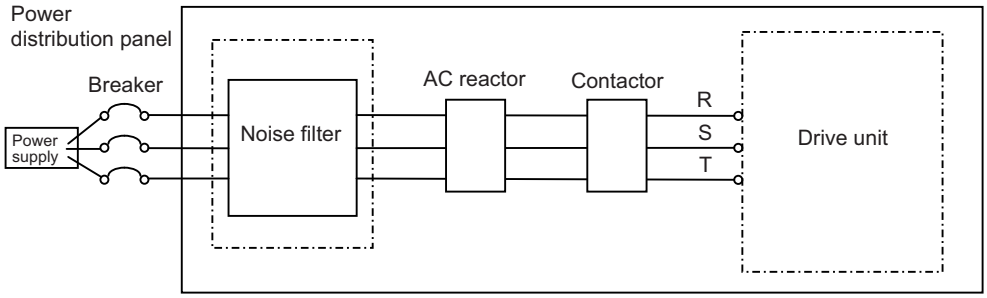
6-5 Noise filter

(1) Selection

Use an EMC noise filter if the noise conducted to the power line must be reduced. Select an EMC noise filter taking the drive unit's input rated voltage and input rated current into consideration.

(2) Noise filter mounting position

Install the noise filter to the drive unit's power input as the diagram below indicates.



(Note) The noise filter must be prepared by the user.

Recommended devices:

Densei-lambda MX13 Series
Soshin Electric HF3000C-TM Series

Contact:

Densei-lambda Co., Ltd. Telephone: 0120-507039 http://www.densei-lambda.com
Soshin Electric Co., Ltd. Telephone: 03-3775-9112 (+81-3-3775-9112) http://www.soshin.co.jp

(Note) The above devices may be changed at the manufacturer's discretion.
Contact each manufacturer for more information.

6-6 Surge absorber

When controlling a magnetic brake of a servomotor in DC OFF circuit, a surge absorber must be installed to protect the relay contacts and brakes. Commonly a varistor is used.

(1) Selection of varistor

When a varistor is installed in parallel with the coil, the surge voltage can be adsorbed as heat to protect a circuit. Commonly a 120V product is applied. When the brake operation time is delayed, use a 220V product. Always confirm the operation with an actual machine.

(2) Specifications

Select a varistor with the following or equivalent specifications. To prevent short-circuiting, attach a flame resistant insulation tube, etc., onto the leads as shown in the following outline dimension drawing.

Varistor specifications

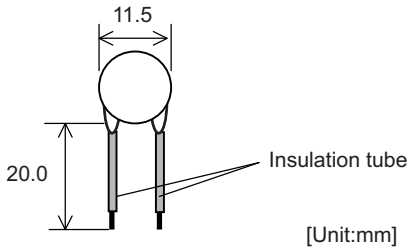
Varistor type	Varistor voltage rating (range)	Rating							Max. limit voltage	Electro-static capacity (reference value)
		Tolerable circuit voltage		Surge current withstand level (A)		Energy withstand level (J)		Power		
	(V)	AC(V)	DC(V)	1 time	2 times	10/1000μs	2ms	(W)	(V)	(pF)
ERZV10D121 TND10V-121K	120 (108 to 132)	75	100	3500	2500	20	14.5	0.4	200	1400
ERZV10D221 TND10V-221K	220 (198 to 242)	140	180	3500	2500	39	27.5	0.4	360	410

(Note 1) Selection condition: When ON/OFF frequency is 10 times/min or less, and exciting current is 2A or less

(Note 2) ERZV10D121 and ERZV10D221 are manufactured by Matsushita Electric Industrial Co., Ltd.
TNR10V121K and TNR10V221K are manufactured by MARCON Electronics Co., Ltd.
Contact: Matsushita Electronic Components Co., Ltd: http://www.panasonic.co.jp/ maco/
MARCON Electronics Co., Ltd. Telephone:
(Kanto)03-3471-7041 (+81-3-3471-7041)
(Kinki) 06-6364-2381 (+81-3-6364-2381)
(Chubu) 052-581-2595 (+81-52-581-2595)

(3) Outline dimension drawing

ERZV10D121, ERZV10D221

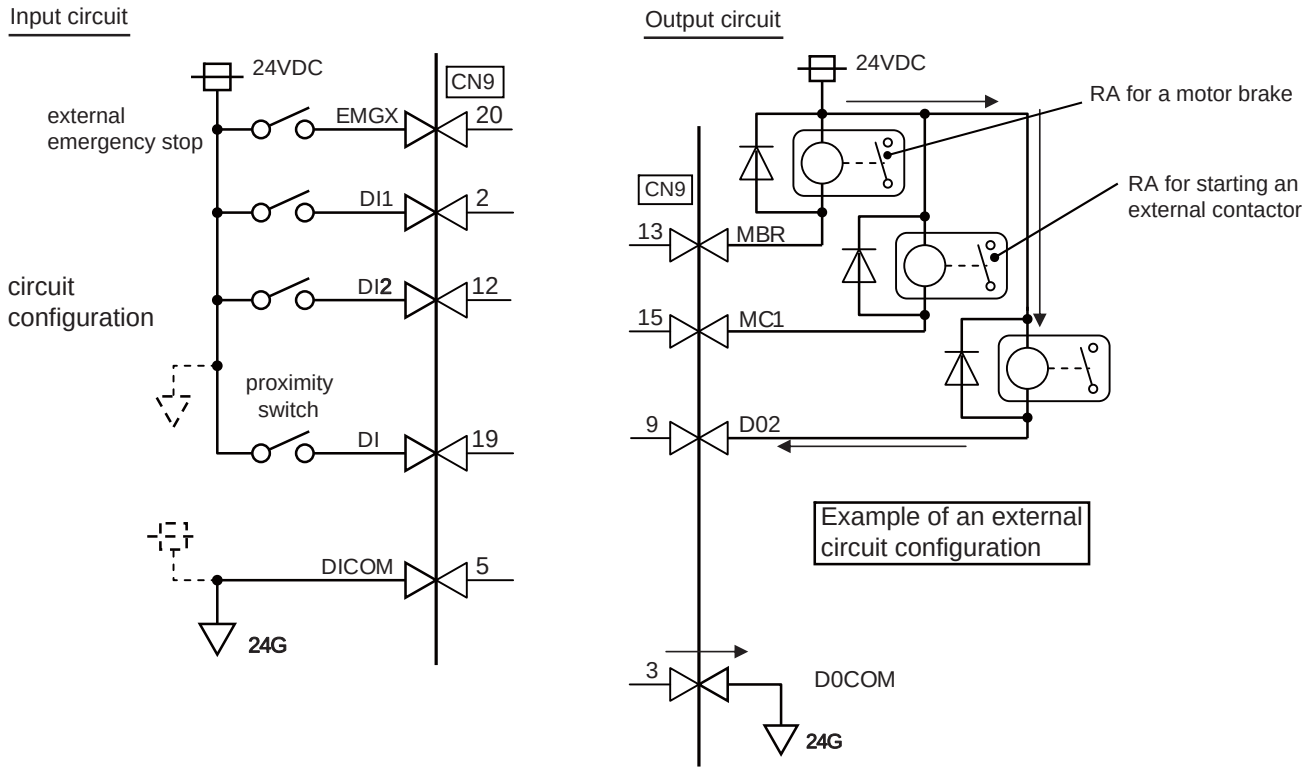


POINT

Normally use a product with 120V varistor voltage. If there is no allowance for the brake operation time, use the 220V product. A varistor whose voltage exceeds 220V cannot be used, as such varistor will exceed the specifications of the relay in the unit.

6-7 Relay

The input/output circuit to control the external signal such as external emergency stop input and relay changeover signal output is wired.
The input/output circuit for each unit is as follows.



	Input condition		Output condition
Switch ON	18VDC to 25.2VDC 5mA or more	**Output voltage**	24VDC ±5%
		Tolerable output current Io	40mA or less
Switch OFF	4VDC or less 1mA or less		

For a switch or relay to be wired, use a switch or relay that satisfies the input/output (voltage, current) conditions.

Interface name	Selection example
For digital input signal (CN9)	Use a minute signal switch which is stably contacted and operated even with low voltage or current. <Example> OMRON: G2A, G6B type, MY type, LY type
For digital output signal (CN9)	Use a compact relay operated with rating of 24VDC, 50mA or less. <Example> OMROM: G6B type, MY type

7

Selection

Contents

7 Selection

7-1 Selection of the servomotor

7-1-1 Outline

It is important to select a servomotor matched to the purpose of the machine that will be installed. If the servomotor and machine to be installed do not match, the motor performance cannot be fully realized, and it will also be difficult to adjust the parameters. Be sure to understand the servomotor characteristics in this chapter to select the correct motor.

(1) Motor inertia

The servomotor series is mainly categorized according to the motor inertia size. The features in Table 7-1 are provided according to the motor inertia size.

Table 7-1 Motor inertia

Motor model	Medium inertia motor	Low inertia motor
Motor series	HF series	HF-KP series
Inertia	The flange size is large. The inertia is comparatively large.	The flange size is small. The inertia is small.
Acceleration/ deceleration	The acceleration/deceleration time constant does not change much even for a low inertia load. The effect of the motor inertia is large.	Acceleration/deceleration is possible with a short time constant in respect to low inertia loads. The effect of the motor inertia is small.
Installation	The motor size in respect to the output capacity is large, and the installation space is large.	The motor size in respect to the output capacity is small, and the installation space is smaller.
Disturbance characteristics	The effect of disturbance is small.	The effect of disturbance is large.
Speed fluctuation	The effect of the torque ripple and cogging torque is small, and speed fluctuation does not occur easily.	The effect of the torque ripple and cogging torque is large, and speed fluctuation occurs easily.
Suitability	Suitable for high precision interpolation control.	Suitable for high speed high frequency positioning.

Select a medium inertia motor when interpolation precision is required, or for machines having a large load inertia. Select a low inertia motor when a shorter positioning time is required by machines having a small amount of inertia. In general, use a medium inertia motor for basic feed axis of machine tools, and use a low inertia motor for machine tool auxiliary axes, peripheral axes, and general industrial machine positioning. The servomotor has an optimum load inertia scale. If the load inertia exceeds the optimum range, the control becomes unstable and the servo parameters become difficult to adjust. When the load inertia is too large, decelerate with the gears (The motor axis conversion load inertia is proportional to the square of the deceleration ratio.), or change to a motor with a large inertia.

(2) Rated speed

Even with motors having the same capacity, the rated speed will differ according to the motor.
The motor's rated output is designed to be generated at the rated speed, and the output P (W) is expressed with expression (7-1). Thus, even when the motors have the same capacity, the rated torque will differ according to the rated speed.

$$P = 2\pi NT \ (W) \qquad \text{---(7-1)}$$

N: Motor speed (1/sec)
T: Output torque (N.m)

In other words, even with motors having the same capacities, the one with the lower rated speed will generate a larger torque. If generated torque is the same, the drive unit capacity can be downsized. When actually mounted on the machine, if the positioning distance is short and the motor cannot reach the maximum speed, the motor with the lower rated speed will have a shorter positioning time. When selecting the motor, consider the axis stroke and usage methods, and select the motor with the optimum rated speed.

7-1-2 Selection of servomotor capacity

The following three elements are used to determine the servomotor capacity.

1. Load inertia ratio
2. Short time characteristics (acceleration/deceleration torque)
3. Continuous characteristics (continuous effective load torque)

Carry out appropriate measures, such as increasing the motor capacity, if any of the above conditions is not fulfilled.

(1) Load inertia ratio

Each servomotor has an appropriate load inertia ratio (load inertia/motor inertia). The control becomes unstable when the load inertia ratio is too large, and the servo parameter adjustment becomes difficult. It becomes difficult to improve the surface precision in the feed axis, and the positioning time cannot be shortened in the positioning axis because the settling time is longer.

If the load inertia ratio exceeds the recommended value in the servo specifications list, increase the motor capacity, and select so that the load inertia ratio is within the recommended range.

Note that the recommended value for the load inertia ratio is strictly one guideline. This does not mean that controlling of the load with inertia exceeding the recommended value is impossible.

POINT

1. When selecting feed axis servomotors for NC unit machine tools, place importance on the surface precision during machining. To do this, always select a servomotor with a load inertia ratio within the recommended value. Select the lowest value possible within that range.
2. The load inertia ratio for the motor with brakes must be judged based on the motor inertia for the motor without brakes.

(2) Short time characteristics

In addition to the continuous operation range, the servomotor has the short time operation range that can be used only in a short time such as acceleration/deceleration. This range is expressed by the maximum torque and the torque characteristics. The maximum torque or the torque characteristics differ according to each motor, so confirm the specifications in section "2-1 Servomotor".

The torque required for the servomotor's acceleration/deceleration differs according to the CNC's command pattern or the servo's position control method.

Determine the required maximum motor torque from the following expression, and select the servomotor capacity.

(a) Selection with the maximum torque characteristics

In a low-speed rotation range (approximately less than half of the servomotor maximum speed), the linear acceleration/deceleration time constant "ta" that can be driven depends on the motor maximum torque. That can be approximated from the machine specifications using the expression (7-2).

$$ta = \frac{1.05 \times 10^{-2} \times (J_L/\eta + J_M) \times N}{(0.8 \times T_{MAX} - T_L)} \quad (ms) \quad \bullet\bullet\bullet \ (7\text{-}2)$$

N	: Motor reach speed	(r/min)
J_L	: Motor shaft conversion load inertia	(kg•cm^2)
J_M	: Motor inertia	(kg•cm^2)
η	: Drive system efficiency (Normally 0.8 to 0.95)	
T_{MAX}	: Maximum motor torque	(N•m)
T_L	: Motor shaft conversion load (friction, unbalance) torque	(N•m)

Using the approximate linear acceleration/deceleration time constant "ta" calculated above, confirm the torque characteristics of the high-speed rotation range in the CNC's command pattern or the servo's position control method.

(b) Approximation when using the NC command linear acceleration/deceleration pattern + servo standard position control

This is a normal command pattern or servo standard position control method.

Using the expression (7-3) and (7-4), approximate the maximum torque "Ta1" and maximum torque occurrence speed "Nm" required for this acceleration/deceleration pattern.

$$Ta1 = \frac{1.05 \times 10^{-2} \times (J_L/\eta + J_M) \times N}{ta} \times (1 - e^{\frac{-Kp \times ta}{1000}}) + T_L \quad (N \cdot m) \quad \bullet\bullet\bullet \ (7\text{-}3)$$

$$Nm = N \times \{1 - \frac{1000}{Kp \times ta} \times (1 - e^{\frac{-Kp \times ta}{1000}})\} \quad (r/min) \quad \bullet\bullet\bullet (7\text{-}4)$$

N	: Motor reach speed	(r/min)
J_L	: Motor shaft conversion load inertia	(kg•cm^2)
J_M	: Motor inertia	(kg•cm^2)
η	: Drive system efficiency (Normally 0.8 to 0.95)	
T_{MAX}	: Maximum motor torque	(N•m)
T_L	: Motor shaft conversion load (friction, unbalance) torque	(N•m)

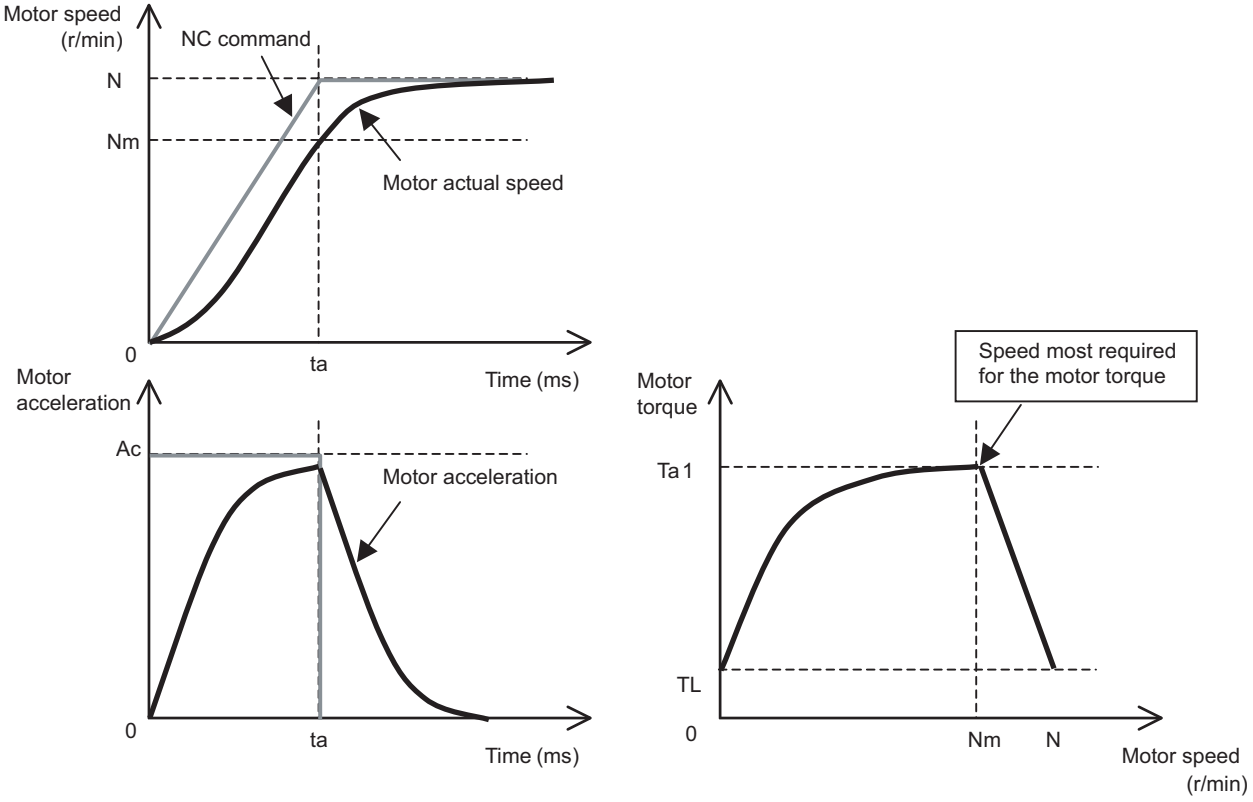


Fig.1 Speed, acceleration and torque characteristics when using the NC command linear acceleration/deceleration pattern + servo standard position control

(c) Approximation when using the NC command linear acceleration/deceleration pattern + servo SHG control (option)

This is a servo's position control method to achieve a normal command pattern and high precision. SHG control improves the position loop gain by stably controlling a delay of the position loop in the servo system. This allows the settling time to be reduced and a high precision to be achieved.

Using the expression (7-5) and (7-6), approximate the maximum torque "Ta1" and maximum torque occurrence speed "Nm" required for this acceleration/deceleration pattern.

$$Ta1 = \frac{1.05 \times 10^{-2} \times (JL/\eta + JM) \times N}{ta} \times (1 - 0.586 \times e^{\frac{-2 \times Kp \times ta}{1000}}) + TL \quad (N \cdot m) \quad \bullet\bullet\bullet \ (7\text{-}5)$$

$$Nm = N \times \{1 - \frac{1000}{1.3 \times Kp \times ta} \times (1 - 1.5 \times e^{\frac{-2 \times Kp \times ta}{1000}})\} \quad (r/min) \quad \bullet\bullet\bullet \ (7\text{-}6)$$

N	: Motor reach speed	(r/min)
J_L	: Motor shaft conversion load inertia	(kg•cm^2)
J_M	: Motor inertia	(kg•cm^2)
η	: Drive system efficiency (Normally 0.8 to 0.95)	
T_{MAX}	: Maximum motor torque	(N•m)
T_L	: Motor shaft conversion load (friction, unbalance) torque	(N•m)

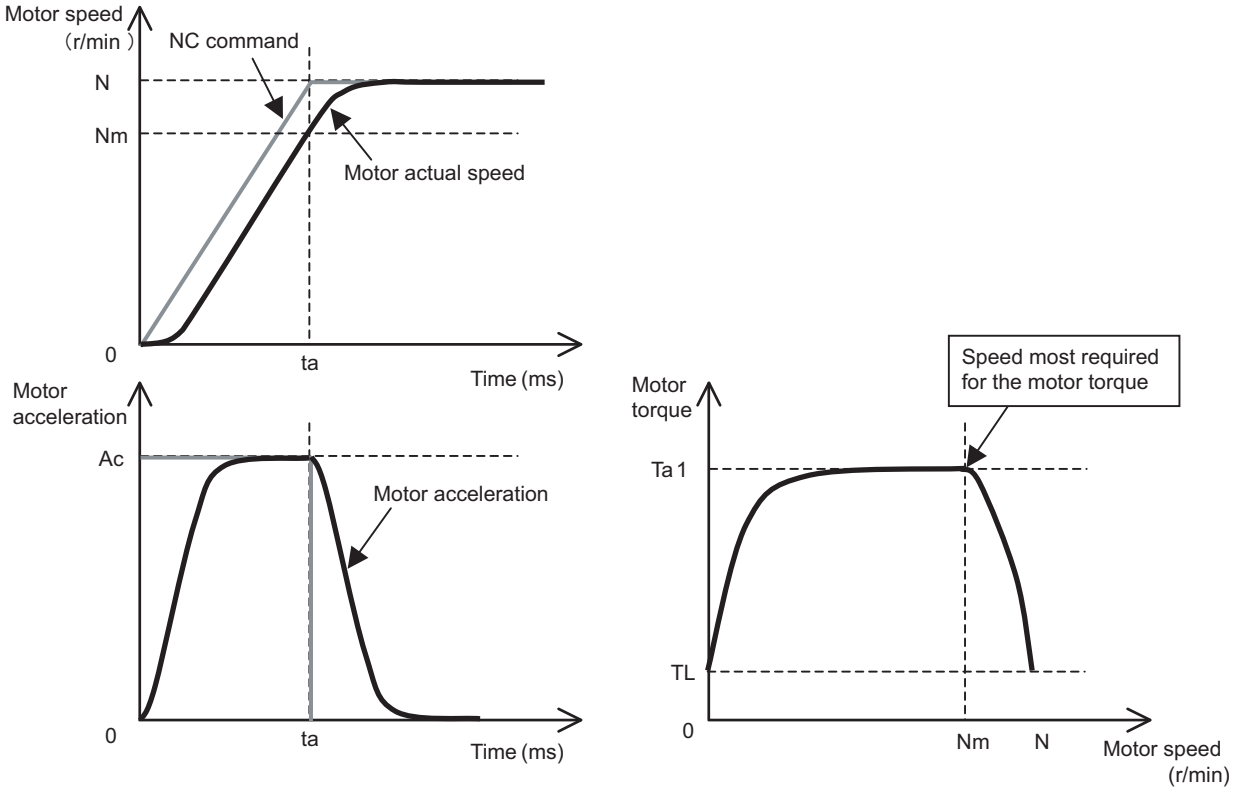


Fig.2 Speed, acceleration and torque characteristics when using the NC command linear acceleration/deceleration pattern + servo SHG control

(d) Approximation when using the NC command soft acceleration/deceleration pattern + feed forward (high-speed accuracy) control

If the feedforward amount is set properly, the delay of the servo position loop is guaranteed. Therefore, this command acceleration pattern can be approximated to the NC command and does not depend on the servo position control method.

Using the expression (7-7) and (7-8), approximate the maximum torque "Ta1" and maximum torque occurrence speed "Nm" required for this acceleration/deceleration pattern.

$$Ta1 = \frac{1.05 \times 10^{-2} \times (JL/\eta + JM) \times N}{ta} + TL \quad (N \cdot m) \quad \bullet\bullet\bullet \ (7\text{-}7)$$

$$Nm = N \times (1 - \frac{1}{2} \times \frac{tb}{ta}) \quad (r/min) \quad \bullet\bullet\bullet \ (7\text{-}8)$$

ta	: Linear acceleration/deceleration time constant	(ms)
tb	: Acceleration/deceleration time constant	(ms)
Kp	: Position loop gain	(rad/sec)
N	: Motor reach speed	(r/min)
J_L	: Motor shaft conversion load inertia	(kg•cm^2)
J_M	: Motor inertia	(kg•cm^2)
η	: Drive system efficiency (Normally 0.8 to 0.95)	
T_L	: Motor shaft conversion load (friction, unbalance) torque	(N•m)

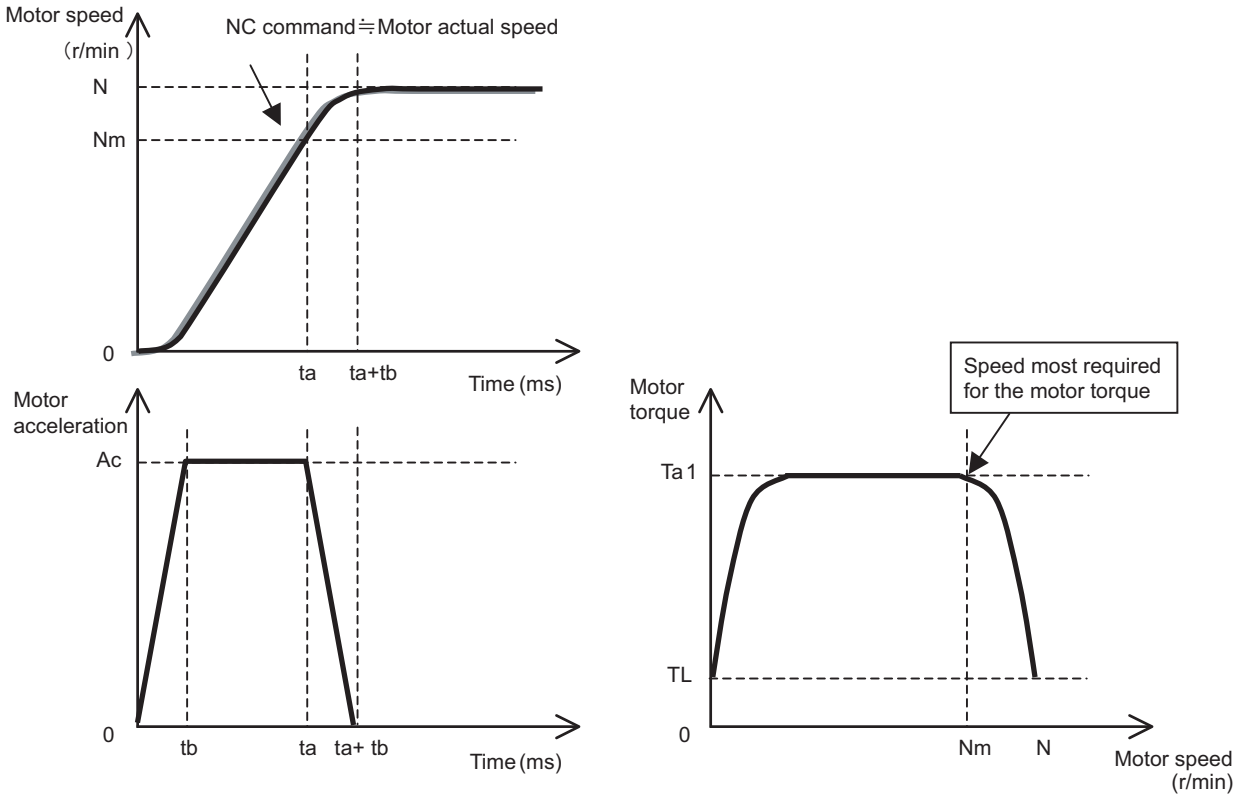
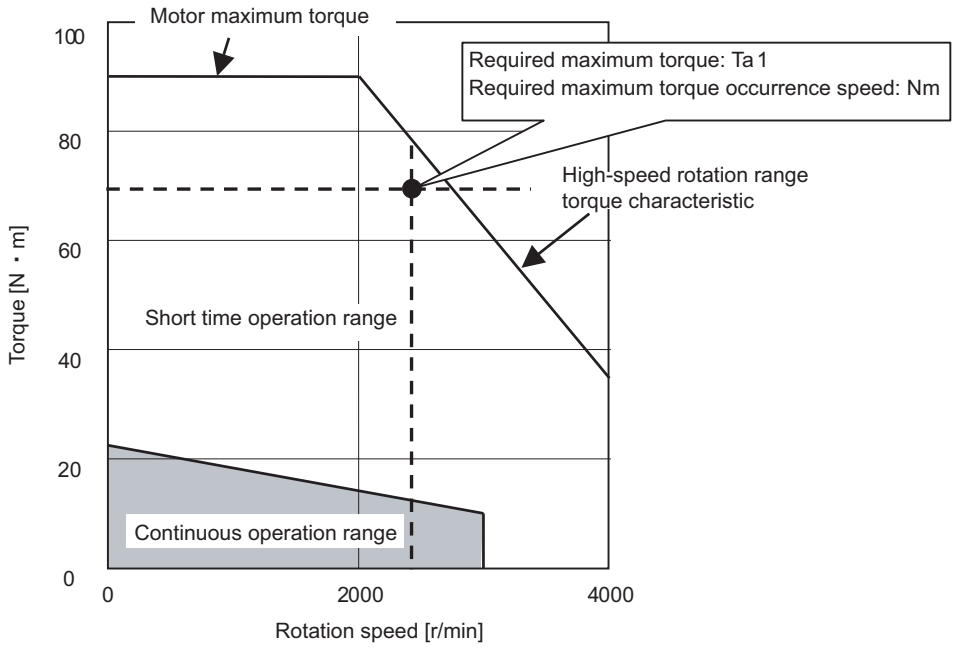


Fig 3. Speed, acceleration and torque characteristic when using the NC command soft acceleration/deceleration pattern + feedforward (high-speed accuracy) control

(e) Confirmation in the torque characteristics
Confirm whether the maximum torque "Ta1" and maximum torque occurrence speed "Nm" required for this acceleration/deceleration pattern calculated in the item "(b)" to "(d)" are in the short time operation range of the torque characteristics.



Motor torque characteristics

If they are not in the short time operation range, return to the item "(b)" to "(d)" and make the linear acceleration/deceleration time constant "ta" large.
If the acceleration specification cannot be changed (the linear acceleration/deceleration time constant cannot be increased), reconsider the selection, such as increasing the motor capacity.

POINT

1. In selecting the maximum torque "Ta1" required for this acceleration/deceleration pattern, the measure of it is 80% of the motor maximum torque "T_{MAX} "
2. In high-speed rotation range, confirm that the maximum torque "Ta1" and maximum torque occurrence speed "Nm" required for this acceleration/deceleration is in the short time operation range.
3. The drive system efficiency is normally approx. 0.95 in the ball screw mechanism and approx. 0.8 in the gear mechanism
4. For the torque characteristics in the motor high-speed rotation range, the AC input voltage is 200V. If the input voltage is low or if the power wire connecting the servomotor and drive unit is long (20m length), the short time operation range is limited. In this case, an allowance must be provided for the selection of the high-speed rotation range.

(3) Continuous characteristics

A typical operation pattern is assumed, and the motor's continuous effective load torque (Trms) is calculated from the motor shaft conversion and load torque. If numbers <1> to <8> in the following drawing were considered a one cycle operation pattern, the continuous effective load torque is obtained from the root mean square of the torque during each operation, as shown in the expression (7-9).

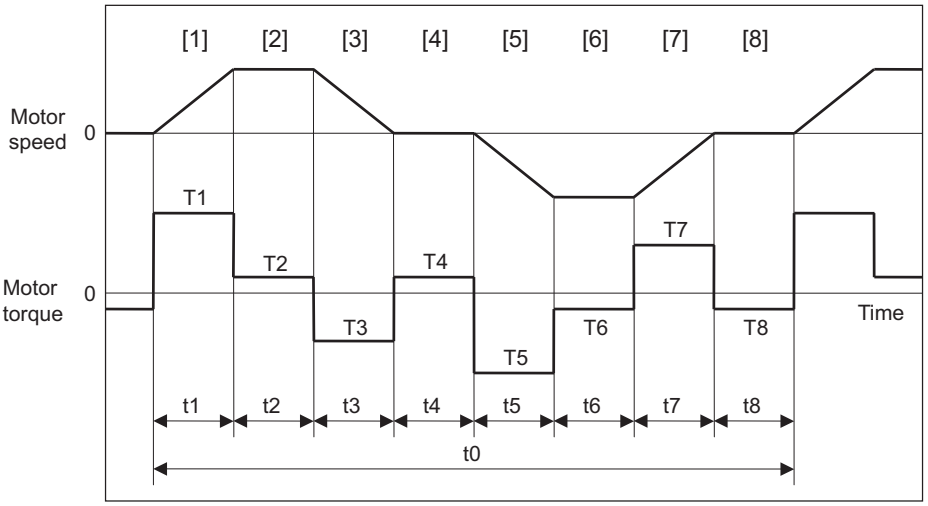


Fig. 1 Continuous operation pattern

$$Trms = \sqrt{\frac{T1^2 \cdot t1 + T2^2 \cdot t2 + T3^2 \cdot t3 + T4^2 \cdot t4 + T5^2 \cdot t5 + T6^2 \cdot t6 + T7^2 \cdot t7 + T8^2 \cdot t8}{t0}} \quad \bullet\bullet\bullet \text{ (7-9)}$$

Select a motor so that the continuous effective load torque Trms is 80% or less of the motor stall torque Tst.

$$Trms \leqq 0.8 \bullet Tst \quad \bullet\bullet\bullet \text{ (7-10)}$$

The amount of acceleration torque (Ta) shown in tables 7-3 and 7-4 is the torque to accelerate the load inertia in a frictionless state. It can be calculated by the expression (7-11). (For linear acceleration/ deceleration)

$$T_a = \frac{1.05 \times 10^{-2} \times (J_L/\eta + J_M) \times N}{ta} \quad (N \cdot m) \quad \bullet\bullet\bullet \text{ (7-11)}$$

N	: Motor reach speed	(r/min)
J_L	: Motor shaft conversion load inertia	(kg•cm^2)
J_M	: Motor inertia	(kg•cm^2)
ta	: Linear acceleration/deceleration time constant	(ms)
η	: Drive system efficiency (Normally 0.8 to 0.95)	

For an unbalance axis, select a motor so that the motor shaft conversion load torque (friction torque + unbalance torque) is 60% or less of the stall.

$$TL \leqq 0.6 \bullet Tst \quad \bullet\bullet\bullet \text{ (7-12)}$$

(a) Horizontal axis load torque

When operations [1] to [8] are for a horizontal axis, calculate so that the following torques are required in each period.

Table 7-3 Load torques of horizontal axes

Period	Load torque calculation method	Explanation
[1]	(Amount of acceleration torque) + (Kinetic friction torque)	Normally the acceleration/deceleration time constant is calculated so that this torque is 80% of the maximum torque of the motor.
[2]	(Kinetic friction torque)	
[3]	(Amount of deceleration torque) + (Kinetic friction torque)	The absolute value of the acceleration torque amount is same as the one of the deceleration torque amount. The signs for the amount of acceleration torque and amount of deceleration torque are reversed.
[4]	(Static friction torque)	Calculate so that the static friction torque is always required during a stop.
[5]	- (Amount of acceleration torque) - (Kinetic friction torque)	The signs are reversed with period <1> when the kinetic friction does not change according to movement direction.
[6]	- (Kinetic friction torque)	The signs are reversed with period <2> when the kinetic friction does not change according to movement direction.
[7]	- (Amount of deceleration torque) - (Kinetic friction torque)	The signs are reversed with period <3> when the kinetic friction does not change according to movement direction.
[8]	- (Static friction torque)	Calculate so that the static friction torque is always required during a stop.

(b) Unbalance axis load torque

When operations [1] to [8] are for an unbalance axis, calculate so that the following torques are required in each period. Note that the forward speed shall be an upward movement.

Table 7-4 Load torques of unbalance axes

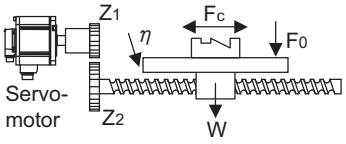
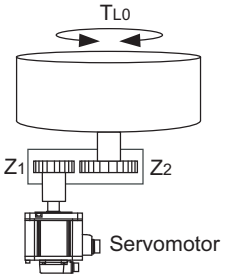
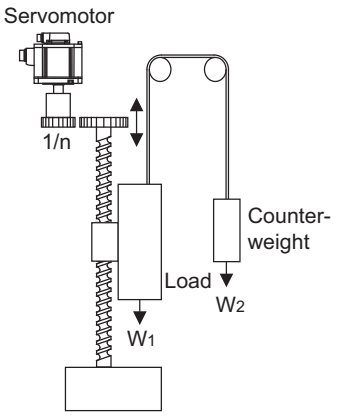
Period	Load torque calculation method	Explanation
[1]	(Amount of acceleration torque) + (Kinetic friction torque) + (Unbalance torque)	Normally the acceleration/deceleration time constant is calculated so that this torque is 80% of the maximum torque of the motor.
[2]	(Kinetic friction torque) + (Unbalance torque)	
[3]	(Amount of deceleration torque) + (Kinetic friction torque) + (Unbalance torque)	The absolute value of the acceleration torque amount is same as the one of the deceleration torque amount. The signs for the amount of acceleration torque and amount of deceleration torque are reversed.
[4]	(Static friction torque) + (Unbalance torque)	The holding torque during a stop becomes fairly large. (Upward stop)
[5]	- (Amount of acceleration torque) - (Kinetic friction torque) + (Unbalance torque)	
[6]	- (Kinetic friction torque) + (Unbalance torque)	The generated torque may be in the reverse of the movement direction, depending on the size of the unbalance torque.
[7]	- (Amount of deceleration torque) - (Kinetic friction torque) + (Unbalance torque)	
[8]	- (Static friction torque) + (Unbalance torque)	The holding torque becomes smaller than the upward stop. (Downward stop)

POINT

During a stop, the static friction torque may constantly be applied. The static friction torque and unbalance torque may be applied during an unbalance axis upward stop, and the torque during a stop may become extremely large. Therefore, caution is advised.

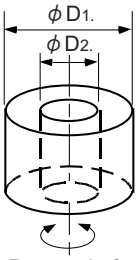
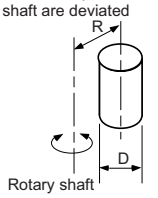
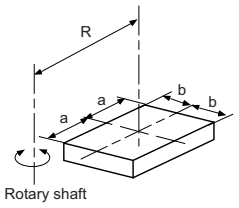
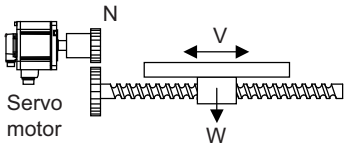
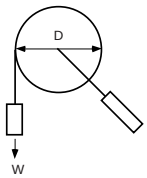
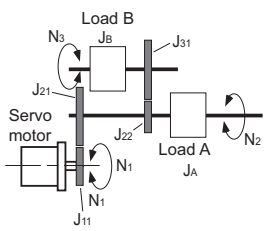
7-1-3 Motor shaft conversion load torque

The calculation method for a representative load torque is shown.

Type	Mechanism	Calculation expression
Linear movement		$T_L = \frac{F}{2\times10^3\pi\eta}\cdot(\frac{V}{N}) = \frac{F\cdot\Delta S}{2\times10^3\pi\eta}$ T_L:Load torque(N•m) F:Force in axial direction of the machine that moves linearly(N) η: Drive system efficiency V:Speed of object that moves linearly(mm/min) N:Motor speed(r/min) ΔS:Object movement amount per motor rotation(mm) Z_1,Z_2:Deceleration ratio **F in the above expression is obtained from the expression below when the table is moved as shown on the left.** **$F=Fc+\mu(W\cdot g+F_0)$** F_c:Force applied on axial direction of moving section (N) F_0:Tightening force on inner surface of table guide (N) W:Total mass of moving section (kg) g:Gravitational acceleration = 9.8 (m/s^2) μ:Friction coefficient
Rotary movement		$T_L = \frac{Z_1}{Z_2}\cdot\frac{1}{\eta}\cdot T_{L0}+T_F = \frac{1}{n}\cdot\frac{1}{\eta}\cdot T_{L0}+T_F$ T_L:Load torque(N•m) T_{L0}:Load torque on load shaft(N•m) T_F:Motor shaft conversion load friction torque(N•m) η:Drive system efficiency Z_1,Z_2:Deceleration ratio n:Deceleration ratio
Vertical movement		**When rising $T_L=T_U+T_F$ When lowering $T_L=-T_U\cdot\eta^2+T_F$** T_L:Load torque(N•m) T_U:Unbalanced torque(N•m) T_F:Friction torque on moving section(N•m) $T_U = \frac{(W_1-W_2)\cdot g}{2\times10^3\pi\eta}\cdot(\frac{V}{N}) = \frac{(W_1-W_2)\cdot g\cdot\Delta S}{2\times10^3\pi\eta}$ $T_F = \frac{\mu\cdot(W_1+W_2)\cdot g\cdot\Delta S}{2\times10^3\pi\eta}$ W_1:Load mass(kg) W_2:Counterweight mass(kg) η: Drive system efficiency g:Gravitational acceleration = 9.8(m/s^2) V:Speed of object that moves linearly(mm/min) N:Motor speed(r/min) ΔS:Object movement amount per motor rotation(mm) μ:Friction coefficient

7-1-4 Expressions for load inertia calculation

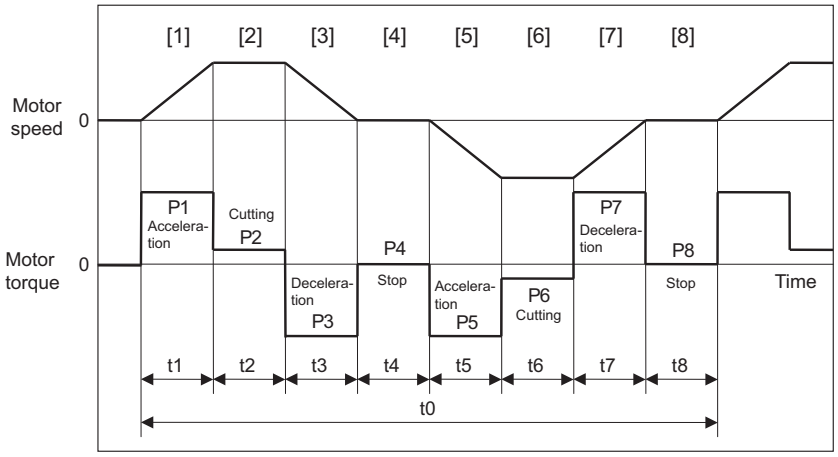
The calculation method for a representative load inertia is shown.

Type	Mechanism	Calculation expression
Cylinder	Rotary shaft is cylinder center  	$J_L = \frac{\pi \cdot \rho \cdot L}{32} \cdot (D_1^4 - D_2^4) = \frac{W}{8} \cdot (D_1^2 + D_2^2)$ T_L:Load inertia(kg•cm^2) ρ: Density of cylinder material(kg/cm^3) L:Length of cylinder(cm) D_1:Outer diameter of cylinder(cm) D_2:Inner diameter of cylinder(cm) W:Mass of cylinder(kg) <Reference data(Material densities)> Iron:7.80×10^{-3}(kg/cm^3) Aluminum:2.70×10^{-3}(kg/cm^3) Copper:8.96×10^{-3}(kg/cm^3)
	When rotary shaft and cylinder shaft are deviated  	$J_L = \frac{W}{8} \cdot (D^2 + 8R^2)$ J_L:Load inertia(kg•cm^2) W:Mass of cylinder(kg) D:Outer diameter of cylinder(cm) R:Distance between rotary axis and cylinder axis(cm)
Column	 	$J_L = W(\frac{a^2+b^2}{3} + R^2)$ J_L: Load inertia(kg•cm^2) W:Mass of cylinder(kg) a,b,R:Left diagram(cm)
Object that moves linearly	 	$J_L = W(\frac{1}{2\pi N} \cdot \frac{V}{10})^2 = W(\frac{\Delta S}{20\pi})^2$ J_L:Load inertia(kg•cm^2) W:Mass of object that moves linearly(kg) N:Motor speed(r/min) V:Speed of object that moves linearly(mm/min) ΔS:Object movement amount per motor rotation(mm)
Suspended object	 	$J_L = W(\frac{D}{2})^2 + J_p$ J_L:Load inertia(kg•cm^2) W:Object mass(kg) D:Diameter of pulley(cm) Jp:Inertia of pulley(kg•cm^2)
Converted load	 	$J_L = J_{11} + (J_{21} + J_{22} + J_A) \cdot (\frac{N_2}{N_1})^2 + (J_{31} + J_B) \cdot (\frac{N_3}{N_1})^2$ J_L:Load inertia(kg•cm^2) J_A,J_B:Inertia of load A, B(kg•cm^2) J_{11}~J_{31}:Inertia(kg•cm^2) N_1~N_3:Each shaft's speed(r/min)

7-2 Selection of the spindle motor

(1) Calculation of average output for spindle

In the machine which carries out the spindle's acceleration/deceleration frequently (example: tapping center), short-time rating is frequently used, and a rise in temperature become significant on the spindle motor or drive unit. Thus, calculate the average output (P_{AV}) from one cycle operation pattern and confirm that the calculated value is less than the continuous rating output of the selected spindle motor.



Continuous operation pattern (example)

$$P_{AV} = \sqrt{\frac{P1^2 \cdot t1 + P2^2 \cdot t2 + P3^2 \cdot t3 + P4^2 \cdot t4 + P5^2 \cdot t5 + P6^2 \cdot t6 + P7^2 \cdot t7 + P8^2 \cdot t8}{t0}}$$

P1 to P8 :Output
t1 to t8 :Time
t0 :One cycle operation time

Continuous rated output $\geqq$ One cycle operation pattern average output (P_{AV})

POINT

1. Calculate acceleration/deceleration time by the accurate load inertia because even if the rotation speed is the same, acceleration/deceleration time varies with a tool or workpiece mounted to the spindle.
   Refer to the section "Adjusting the acceleration/deceleration operation" (1) in Instruction Manual.
2. Calculation method of synchronous tapping
   The acceleration/deceleration number of times is twice, for forward run and reverse run are carried out in one machining. The output guideline is 50% of the short-time rating. The time is tapping time constant.
3. Calculation method of spindle synchronization
   The output guideline is 70% of the short-time rating. The time is spindle synchronization time constant.

7-3 Selection of the regenerative resistor

7-3-1 Regeneration methods

When the motor decelerates, rotating load inertia or the operation energy of the moving object is returned to the drive unit through the motor as electrical power. This is called "regeneration". The three general methods of processing regeneration energy are shown below.

Table 7-5 Drive unit regeneration methods

Regeneration method	Explanation
1. Condenser regeneration method	This is a regeneration method for small-capacity drive units. The regeneration energy is charged to the condenser in the drive unit, and this energy is used during the next acceleration. The regeneration capacity decreases as the power supply voltage becomes higher.
2. Resistance regeneration method	If the condenser voltage rises too high when regenerating with the condenser only, the regenerative electrical power is consumed using the resistance. If the regeneration energy is small, it will only be charged to the condenser. Because regeneration energy becomes heat due to resistance, heat radiation must be considered. In large capacity drive units the regenerative resistance becomes large and this is not practical.
3. Power supply regeneration method	This is a method to return the regeneration energy to the power supply. The regeneration energy does not become heat as in regenerative resistance. (Heat is generated due to regeneration efficiency problems.) The circuit becomes complicated, but in large capacity drive units having large regeneration capacity this method improves regeneration frequency than regenerative resistor.

The resistance regeneration method are used in the MDS-D-SVJ3/SPJ3. For MDS-D-SVJ3 Series (servo), the regenerative resistor is mounted in the drive unit as a standard. If the regenerative capacity becomes large, an option regenerative resistor is connected externally to the unit. (Combined use with the built-in resistor is not possible.)
When the power supply regeneration method is used, consider using the MDS-D-V1/V2, MDS-D-SP/SP2 Series, MDS-DM-SPV Series.

POINT

Make sure to mount the optional regenerative resistor outside the MDS-D-SPJ3 Series (spindle) unit.
A built-in regenerative resistor is not mounted.

7-3-2 Calculation of the regenerative energy

Calculate the regenerative energy for stopping from each axis' rapid traverse rate (maximum rotation speed for spindle), and select a regenerative resistor having a capacity that satisfies the positioning frequency determined from the machine specifications.

(1) For horizontal servo axis and spindle

The regenerative energy E_R consumed by the regenerative resistor can be calculated from expression (7-13). If the E_R value is negative, all of the regenerative energy is absorbed by the capacitor in the drive unit (capacitor regeneration), and the energy consumed by the regenerative resistor is zero (E_R= 0).

$$E_R = 5.48 \times 10^{-7} \cdot \eta \cdot (J_L + J_M) \cdot N^2 - Ec \quad (J) \quad \bullet\bullet\bullet (7\text{-}13)$$

η	:Motor reverse efficiency	
J_L	:Motor inertia	(kg•cm^2)
J_M	:Load inertia	(kg•cm^2)
N	:Motor speed	(r/min)
Ec	:Unit charging energy	(J)

(Example)When a load with the same inertia as the motor is connected to the HF54, determine the regenerative energy to stop from the rated rotation speed. Note that the drive unit is MDS-D-SVJ3-07NA in this case.

According to expression (7-13), the regenerative energy E_R is:

$E_R=5.48\times10^{-7}\times0.85\times(6.1+6.1)\times3000^2-18 =33.1(J)$

Drive unit charging energy

Drive unit	Charging energy Ec (J)	Drive unit	Charging energy Ec(J)
MDS-D-SVJ3-03NA	9	**MDS-D-SPJ3-075NA**	18
MDS-D-SVJ3-04NA	11	**MDS-D-SPJ3-22NA**	40
MDS-D-SVJ3-07NA	18	**MDS-D-SPJ3-37NA**	40
MDS-D-SVJ3-10NA	30	**MDS-D-SPJ3-55NA**	45
MDS-D-SVJ3-20NA	40	**MDS-D-SPJ3-75NA**	45
MDS-D-SVJ3-35NA	40	**MDS-D-SPJ3-110NA**	90

Motor reverse efficiency

Motor	Motor reverse efficiency η	Motor	Motor reverse efficiency η
HF75,105	0.85	**All spindle motors**	0.90
HF54, 104, 154, 224, 123, 223, 142	0.85		
HF204, 354, 303, 302	0.85		
HF-KP13	0.55		
HF-KP23	0.70		
HF-KP43	0.85		
HF-KP73	0.85		

POINT The charging energy values apply when the unit input power voltage is 220V. If the input voltage is higher, the charging energy decreases, and the regenerative energy increases.

(2) For servo unbalance axis

The regenerative energy differs in the upward stop and downward stop for an unbalance axis. A constant regeneration state results during downward movement if the unbalance torque is the same as or larger than the friction torque.

Regenerative energy		
Upward stop	A regenerative state only occurs when deceleration torque (downward torque) is generated. $E_{RU} = 5.24 \times 10^{-5} \cdot \eta \cdot T_{du} \cdot N \cdot t_d - Ec$ (J) ••• (7-14) η :Motor reverse efficiency T_{du} :Upward stop deceleration torque (N•m) N :Motor speed (r/min) t_d :Deceleration time (time constant) (ms) Ec :Unit charging energy (J)	
Downward stop	A regenerative state occurs even during constant rate feed when the upward torque Ts during dropping is generated. Calculate so that Ts = 0 when Ts is downward. $E_{RD} = \frac{2\pi \cdot \eta \cdot Ts \cdot L}{\Delta S} + 5.24 \times 10^{-5} \cdot \eta \cdot T_{dd} \cdot N \cdot t_d - Ec$ (J) ••• (7-15) η :Motor reverse efficiency Ts :Upward torque during dropping (N•m) L :Constant speed travel (mm) ΔS :Travel per motor rotation (mm) T_{dd} :Downward stop deceleration torque (N•m) N :Motor speed (r/min) t_d :Deceleration time (time constant) (ms) Ec :Unit charging energy (J)	
The regenerative energy per cycle (E_R) is obtained using expression (7-16) using one reciprocation as one cycle. $E_R = E_{RU} + E_{RD}$ (J) ••• (7-16)		

(Example)

Using a machine tool vertical axis driven by an HF154 motor, reciprocation is carried out with F30000 at an acceleration/deceleration time constant of 100ms for a distance of 200mm. Obtain the regenerative energy per reciprocation operation in this case.

Where:

Servo drive unit	: MDS-D-SVJ3-20NA
Travel per motor rotation	: 10 mm
Upward stop deceleration torque	: 20 N•m
Downward stop deceleration torque	: 30 N•m
Upward torque during downward movement	: 3 N•m

Using expression (7-14), the upward stop regenerative energy E_{RU} is as follows:

$$E_{RU} = 5.24 \times 10^{-5} \times 0.85 \times 20 \times 3000 \times 100 - 40 = 227.2 \text{ (J)}$$

The acceleration/deceleration distance required to accelerate at the 100ms acceleration/deceleration time constant to 30000mm/min. is as follows:

$$\frac{30000 \times 100}{2 \times 60 \times 1000} = 25 \text{ (mm)}$$

Therefore, the constant speed travel is 150mm.

The downward stop regenerative energy E_{RD} is obtained using the following expression (7-15).

$$E_{RD} = \frac{2\pi \times 0.85 \times 3 \times 150}{10} + 5.24 \times 10^{-5} \times 0.85 \times 30 \times 3000 \times 100 - 40 = 601.2 \text{ (J)}$$

Thus, the regenerative energy per reciprocation operation E_R is as follows:

$$E_R = 227.2 + 601.2 = 828.4 \text{ (J)}$$

7-3-3 Calculation of the positioning frequency

Select the regenerative resistor so that the positioning frequency (deceleration stopping frequency for spindle) DP (times/minute) calculated from the regenerative resistor capacity P_R (W) and regenerative energy E_R (J) consumed by the regenerative resistor is within the range shown in expression (7-17). For the unbalance axis, calculate using the regenerative energy E_R per reciprocation operation, and judge the numbers of operation cycles for rising and lowering as DP.

$$DP < 48 \cdot \frac{P_R}{E_R} \quad \text{(times/minute)} \quad \bullet\bullet\bullet \ (7\text{-}17)$$

List of servo regenerative resistor correspondence

Corresponding servo drive unit	Standard built-in regenerative resistor		External option regenerative resistor						
			MR-RB032	MR-RB12	MR-RB32	MR-RB30	MR-RB50	MR-RB31	MR-RB51
					GZG200W120OHMK ×3 units	GZG200W39OHMK ×3 units	GZG300W39OHMK ×3 units	GZG200W20OHMK ×3 units	GZG300W20OHMK ×3 units
	Parameter setting value		1200h	1300h	1400h	1500h	1600h	1700h	1800h
	Regenerative capacity		30W	100W	300W	300W	500W	300W	500W
		Resistance value	40Ω	40Ω	40Ω	13Ω	13Ω	6.7Ω	6.7Ω
MDS-D-SVJ3-03NA	10W	100Ω	○	○					
MDS-D-SVJ3-04NA	10W	100Ω	○	○					
MDS-D-SVJ3-07NA	20W	40Ω	○	○	○				
MDS-D-SVJ3-10NA	100W	13Ω				○	○		
MDS-D-SVJ3-20NA	100W	9Ω						○	○
MDS-D-SVJ3-35NA	100W	9Ω						○	○

Corresponding servo drive unit	Standard built-in regenerative resistor		External option regenerative resistor					
			FCUA-RB22	FCUA-RB37	FCUA-RB55	R-UNIT2	FCUA-RB55 2 units connected in parallel	FCUA-RB75/2 2 units connected in parallel
	Parameter setting value		2400h	2500h	2600h	2900h	2E00h	2D00h
	Regenerative capacity		155W	185W	340W	700W	680W	680W
		Resistance value	40Ω	25Ω	20Ω	15Ω	10Ω	15Ω
MDS-D-SVJ3-03NA	10W	100Ω						
MDS-D-SVJ3-04NA	10W	100Ω						
MDS-D-SVJ3-07NA	20W	40Ω	○					
MDS-D-SVJ3-10NA	100W	13Ω		○	○	○		○
MDS-D-SVJ3-20NA	100W	9Ω				○	○	○
MDS-D-SVJ3-35NA	100W	9Ω					○	

7 Selection

List of spindle regenerative resistor correspondence

Corresponding spindle drive unit		External option regenerative resistor			
		MR-RB12	MR-RB32	MR-RB30	MR-RB50
			GZG200W120 OHMK×3 units	GZG200W39 OHMK×3 units	GZG300W39 OHMK×3 units
	Parameter setting value	1300h	1400h	1500h	1600h
	Regenerative capacity	100W	300W	300W	500W
	Resistance value	40Ω	40Ω	13Ω	13Ω
MDS-D-SPJ3-075NA	---	○	○		
MDS-D-SPJ3-22NA	---			○	○
MDS-D-SPJ3-37NA	---			○	○
MDS-D-SPJ3-55NA	---			○	○
MDS-D-SPJ3-75NA	---				○
MDS-D-SPJ3-110NA	---				

Corresponding spindle drive unit		External option regenerative resistor			
		FCUA-RB22	FCUA-RB37	FCUA-RB55	FCUA-RB75/2 (1 unit)
	Parameter setting value	2400h	2500h	2600h	2700h
	Regenerative capacity	155W	185W	340W	340W
	Resistance value	40Ω	25Ω	20Ω	30Ω
MDS-D-SPJ3-075NA	---	○	○		
MDS-D-SPJ3-22NA	---	○	○	○	○
MDS-D-SPJ3-37NA	---		○	○	○
MDS-D-SPJ3-55NA	---			○	
MDS-D-SPJ3-75NA	---				
MDS-D-SPJ3-110NA	---				

Corresponding spindle drive unit		External option regenerative resistor						
		R-UNIT1	R-UNIT2	R-UNIT3	R-UNIT4	R-UNIT5	FCUA-RB55 2 units connected in parallel	FCUA-RB75/2 2 units connected in parallel
	Parameter setting value	2800h	2900h	2A00h	2B00h	2C00h	2E00h	2D00h
	Regenerative capacity	700W	700W	2100W	2100W	3100W	680W	680W
	Resistance value	30Ω	15Ω	15Ω	10Ω	10Ω	10Ω	15Ω
MDS-D-SPJ3-075NA	---							
MDS-D-SPJ3-22NA	---	○	○	○				○
MDS-D-SPJ3-37NA	---	○	○	○	○	○	○	○
MDS-D-SPJ3-55NA	---		○	○	○	○	○	○
MDS-D-SPJ3-75NA	---		○	○	○	○	○	○
MDS-D-SPJ3-110NA	---				○	○		

⚠ CAUTION MDS-D-SPJ3 (spindle) unit is not equipped with a built-in regenerative resistor.
Thus, always mount the optional regenerative resistor outside the unit.

Appendix 1

Cable and Connector Specifications

Contents

Appendix 1 Cable and Connector Specifications

Appendix 1-1 Selection of cable

Appendix 1-1-1 Cable wire and assembly

(1) Cable wire

The specifications of the wire used for each cable, and the machining methods are shown in this section. When manufacturing the detector cable and battery connection cable, use the recommended wires shown below or equivalent products.

(a) Heat resistant specifications cable

Wire type (other manufacturer's product)	Finish outer diameter	Sheath material	No. of pairs	Wire characteristics					
				Configuration	Conductive resistor	Withstand voltage	Insulation resistance	Heat resistance temperature	Flexibility
BD20288 Compound 6-pair shielded cable Specification No. Bangishi-17145 (Note 1)	8.7mm	Heat resistant PVC	2 ($0.5mm^2$)	100 strands/ 0.08mm	40.7Ω/km or less	500VAC/ 1min	1000 MΩ/km or more	105°C	$70×10^4$ times or more at R200
			4 ($0.2mm^2$)	40 strands/ 0.08mm	103Ω/km or less				

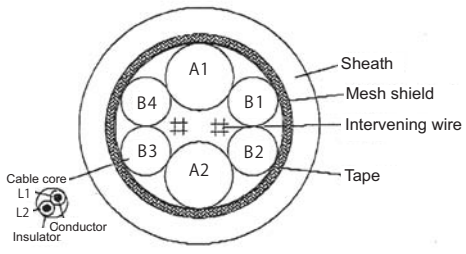
(b) General-purpose heat resistant specifications cable

Wire type (other manufacturer's product)	Finish outer diameter	Sheath material	No. of pairs	Wire characteristics					
				Configuration	Conductive resistor	Withstand voltage	Insulation resistance	Heat resistance temperature	Flexibility
BD20032 Compound 6-pair shielded cable Specification No. Bangishi-16903 Revision No. 3 (Note 2))	8.7mm	PVC	2 ($0.5mm^2$)	100strands/ 0.08mm	40.7Ω/km or less	500VAC/ 1min	1000 MΩ/km or more	60°C	$100×10^4$ times or more at R200
			4 ($0.2mm^2$)	40strands/ 0.08mm	103Ω/km or less				

(Note 1) Bando Electric Wire (Contact: 81+48-461-0561 http://www.bew.co.jp)

(Note 2) The Mitsubishi standard cable is the (a) Heat resistant specifications cable. For MDS-C1/CH series, (b) or equivalent is used as the standard cable.

Compound 6-pair cable structure drawing

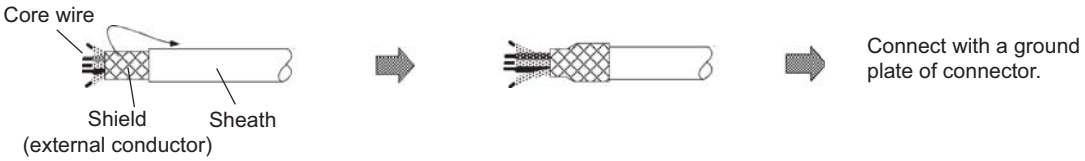


Core identification

Pair No.	Insulator color	
	L1	L2
A1 ($0.5mm^2$)	Red	White
A2 ($0.5mm^2$)	Black	White
B1 ($0.2mm^2$)	Brown	Orange
B2 ($0.2mm^2$)	Blue	Green
B3 ($0.2mm^2$)	Purple	White
B4 ($0.2mm^2$)	Yellow	White

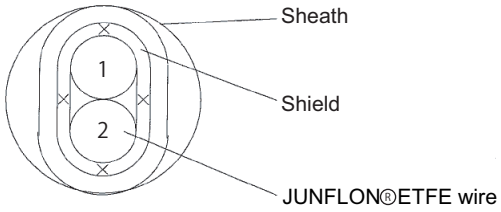
(2) Cable assembly

Assemble the cable with the cable shield wire securely connected to the ground plate of the connector.



(3) Battery connection cable

Wire type (other manufacturer's product)	Finish outer diameter	Sheath material	No. of pairs	Wire characteristics					
				Configuration	Conductive resistor	Withstand voltage	Insulation resistance	Heat resistance temperature	Minimum bend radius
J14B101224-00 Two core shield cable	3.3mm	PVC	1 ($0.2mm^2$)	7strands / 0.2mm	91.2Ω/km or less	AC500V/ 1min	1000MΩ/ km or less	80°C	R33mm



Two core shield cable structure drawing

Core identification

No.	Insulator color
1	Red
2	Black

Appendix 1 Cable and Connector Specifications

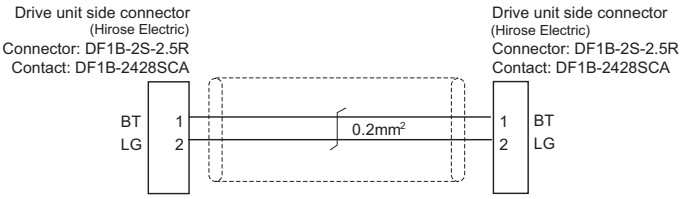
Appendix 1-2 Cable connection diagram

⚠ CAUTION

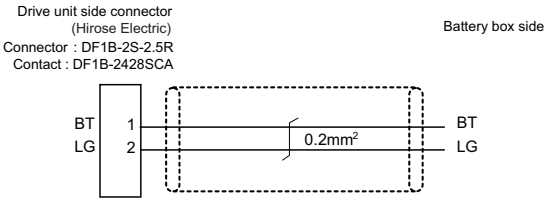
1. Take care not to mistake the connection when manufacturing the detector cable. Failure to observe this could lead to faults, runaway or fire.
2. When manufacturing the cable, do not connect anything to pins which have no description.

Appendix 1-2-1 Battery cable

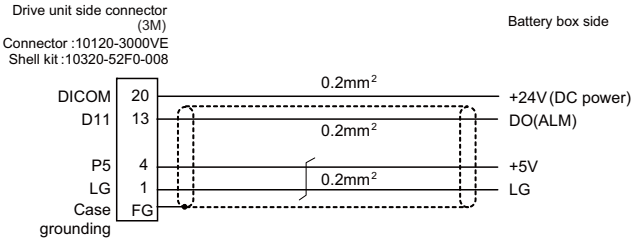
<DG22 cable connection diagram (Connection cable between drive unit and drive unit)>



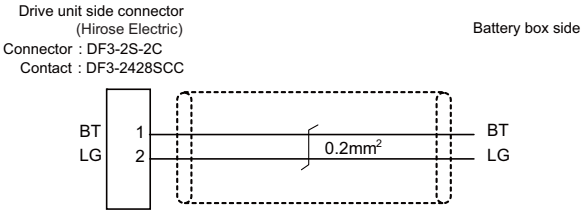
<DG23 cable connection diagram (Connection cable between drive unit and MDS-BTBOX-36)>



<DG24 cable connection diagram
(Connection cable for alarm output between drive unit and MDS-BTBOX-36)>



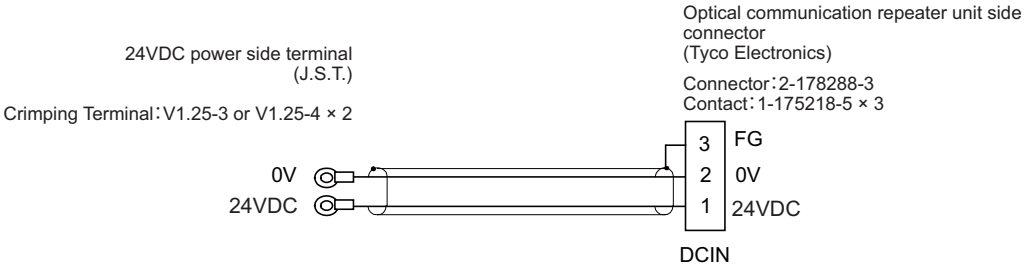
<DG25 cable connection diagram (Connection cable between drive unit and MDS-BTBOX-36)>



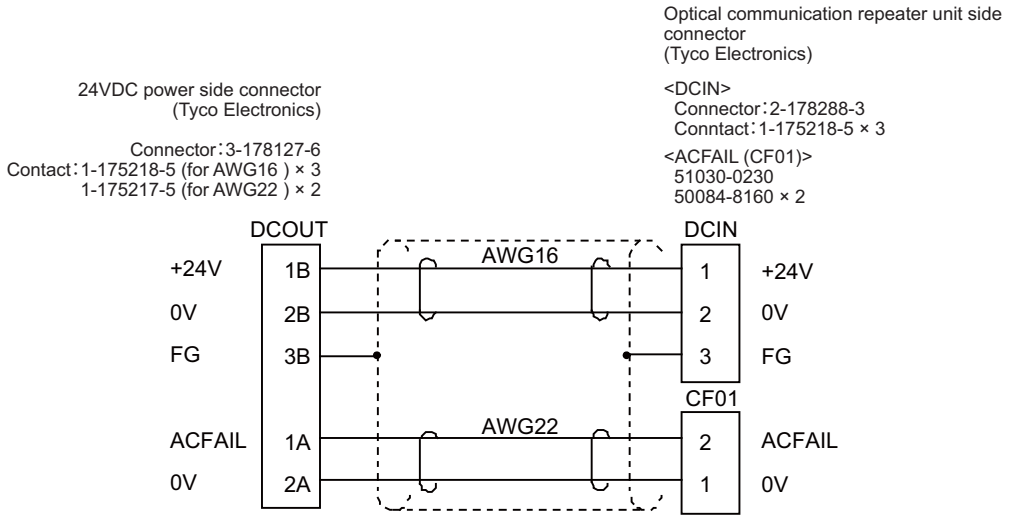
CAUTION ! When DG24 cable is used, proximity switch or external emergency stop cannot be wired, so these functions cannot be used.

Appendix 1-2-2 Optical communication repeater unit cable

< F070 cable connection diagram >



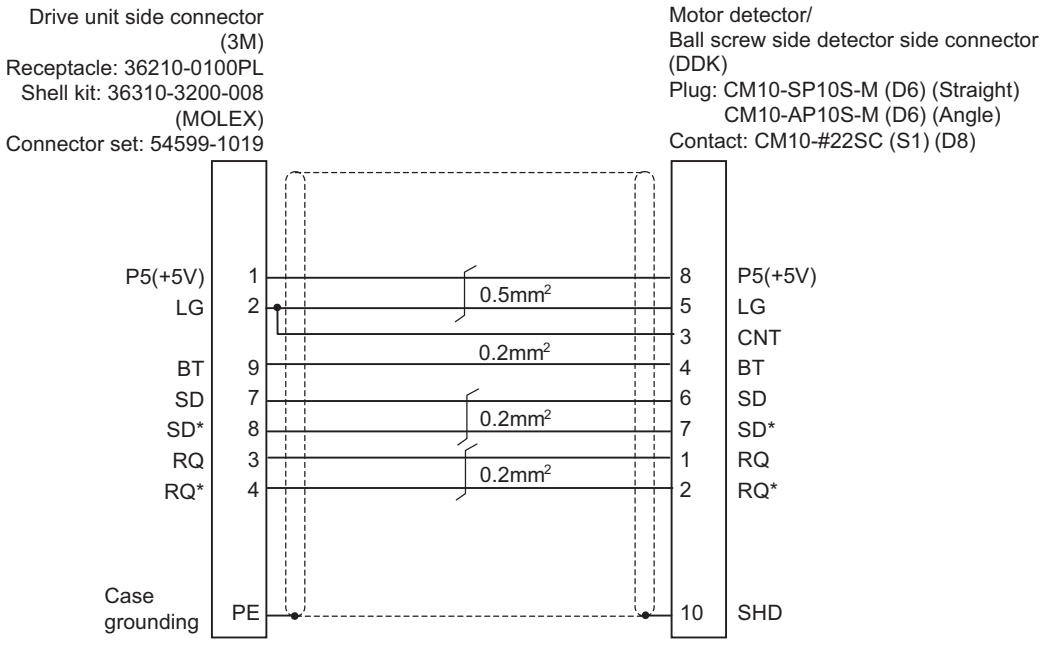
< F110 cable connection diagram >



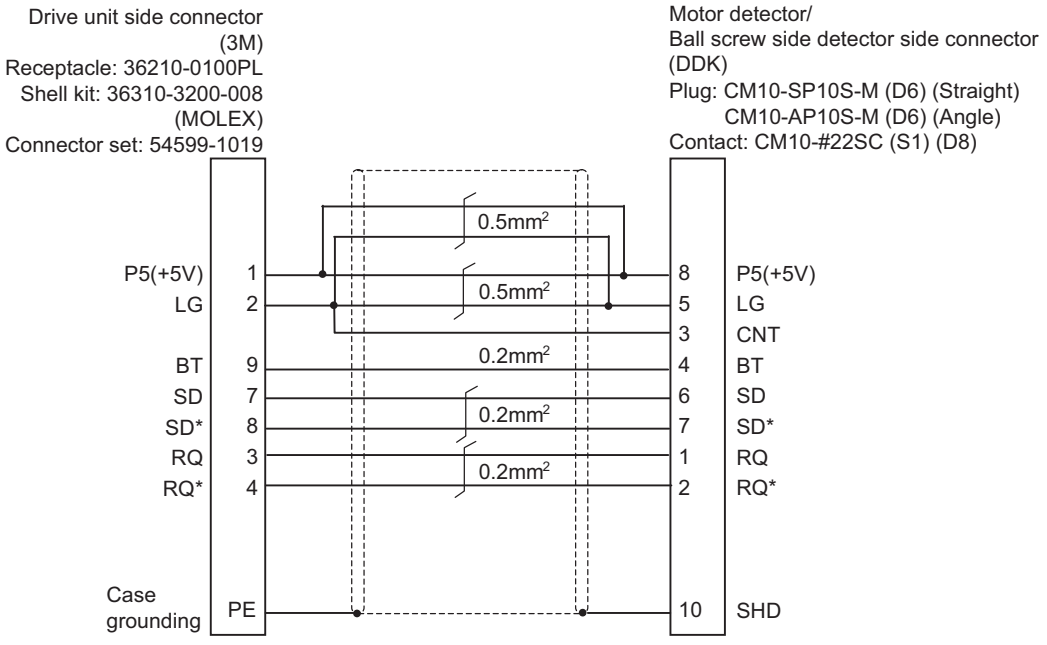
Appendix 1 Cable and Connector Specifications

Appendix 1-2-3 Servo / tool spindle detector cable

<CNV2E-8P, CNV2E-9P cable connection diagram>



<For 15m or less>

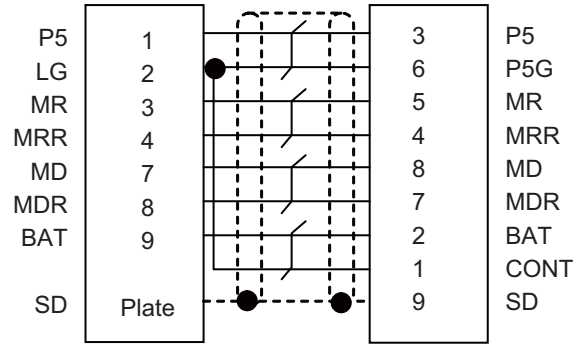


<For 15m to 30m>

< CNV2E-K1P, CNV2E-K2P cable connection diagram (Direct connection type) >

Servo drive unit side connector
(3M)
Receptacle : 36210-0100PL
Shell kit : 36310-3200-008
(MOLEX)
Connector set : 54599-1019

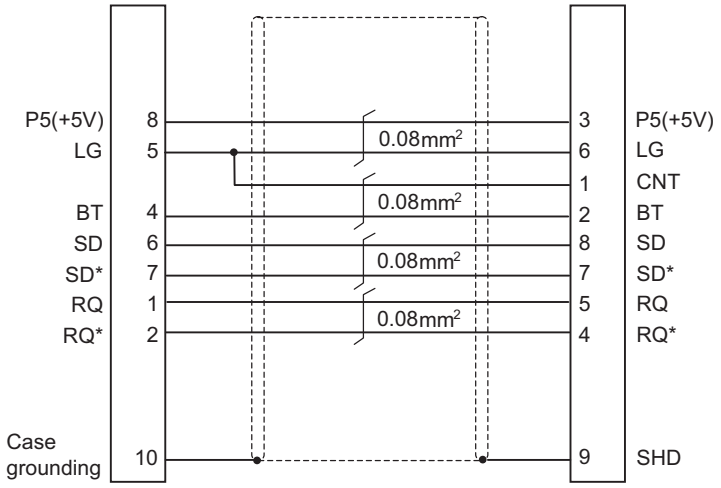
Servo motor detector connector
(Tyco Electronics)
Connector : 1674320-1



< CNV22J-K1P, CNV22J-K2P cable connection diagram (Relay type) >

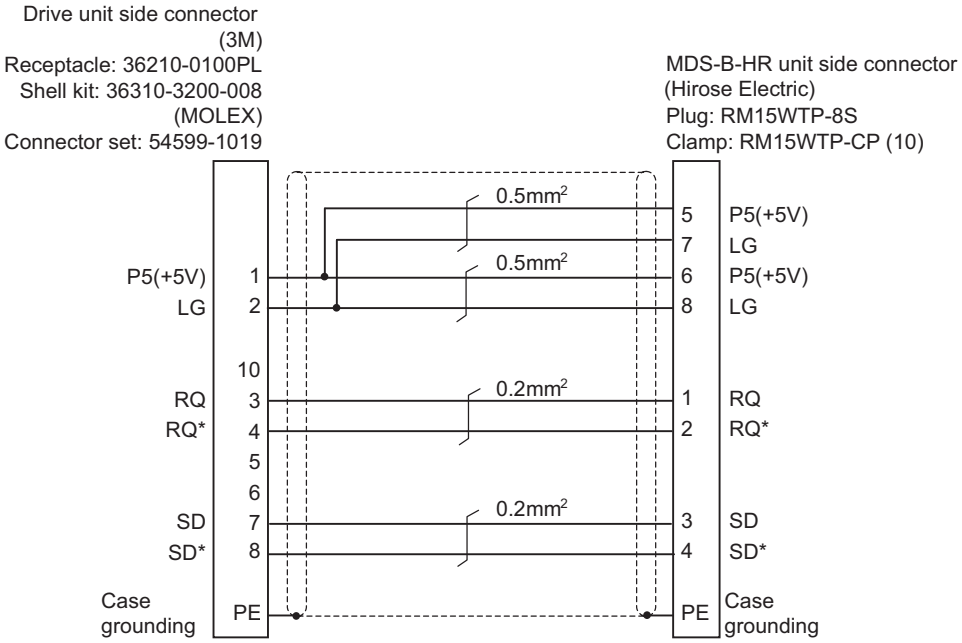
Drive unit side connector
(DDK)
Plug: CM10-CR10P-M

Motor detector/
Ball screw side detector side connector
(Tyco Electronics)
Plug: 1747464-1
Contact: 1674335-4

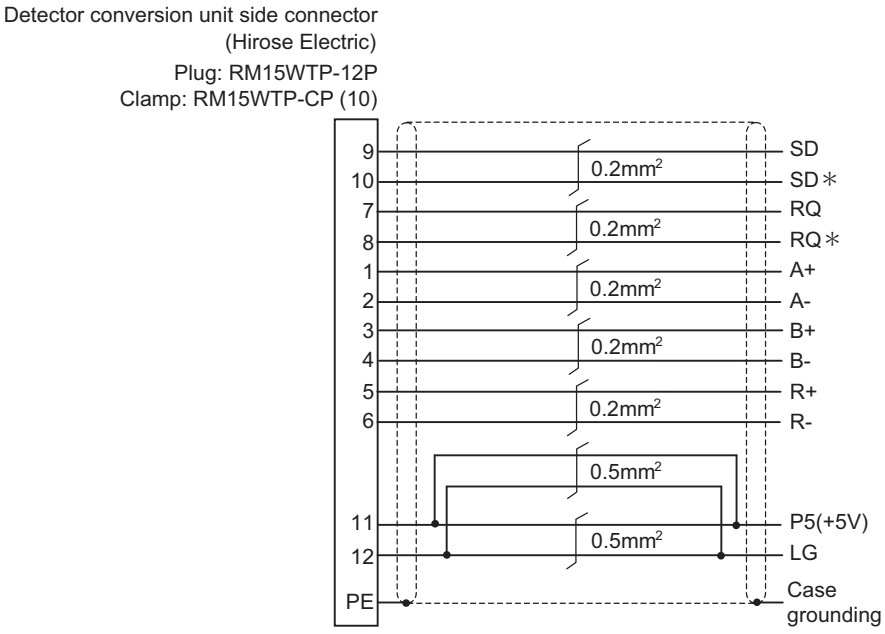


Appendix 1 Cable and Connector Specifications

<CNV2E-HP cable connection diagram>

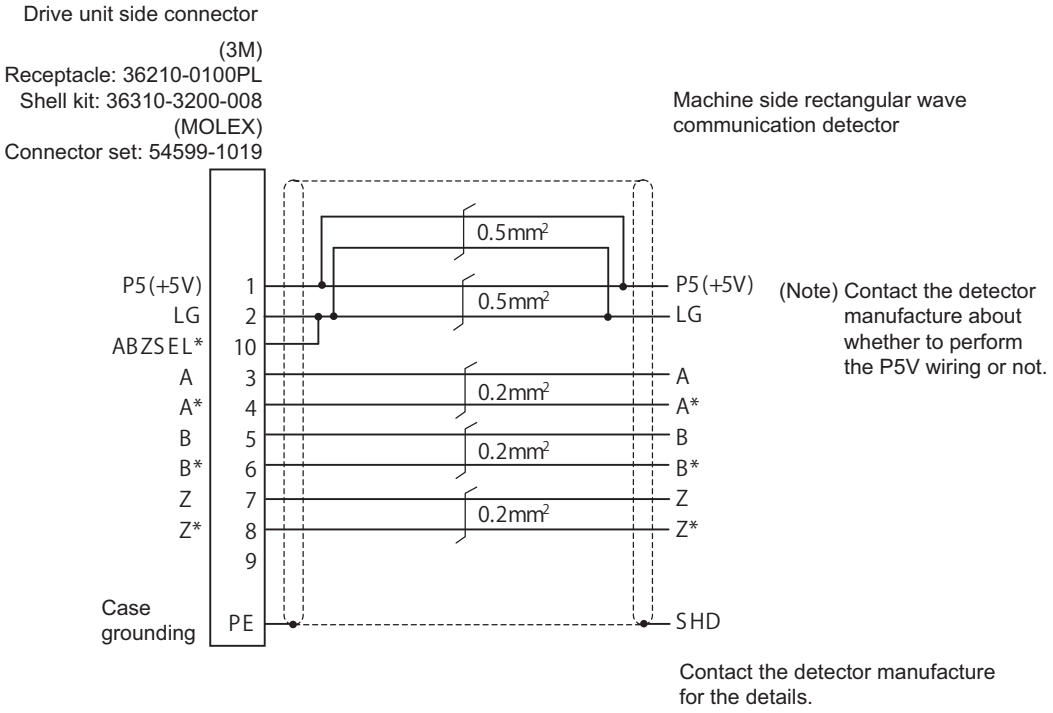


<Cable connection diagram between scale I/F unit and scale (CNLH3 cable, etc.) >



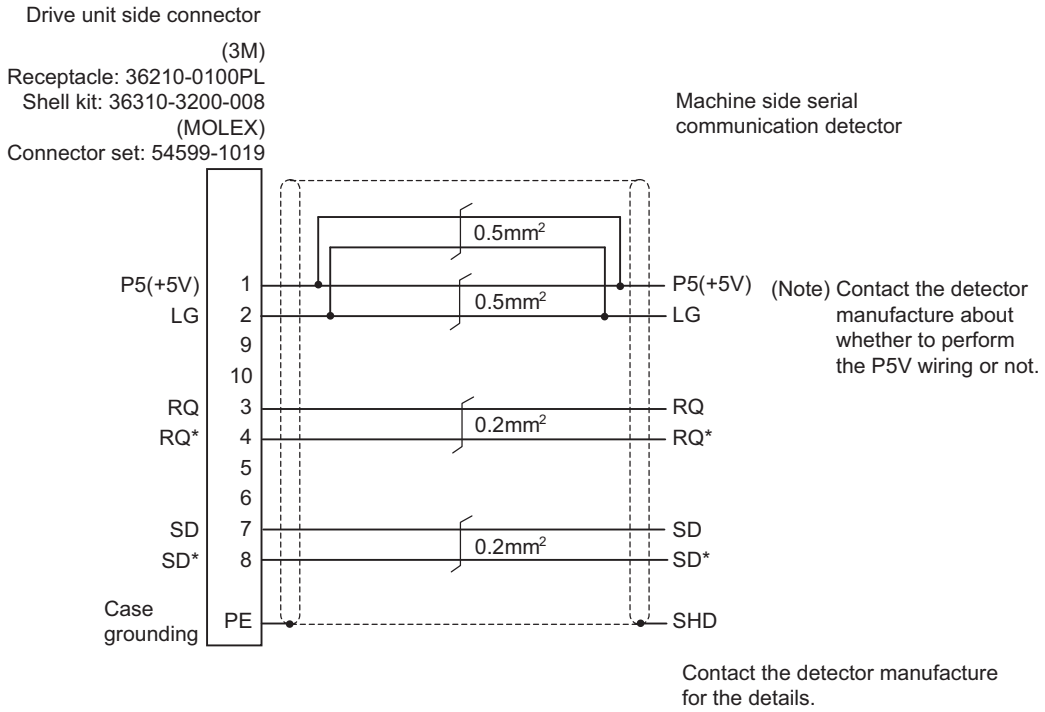
(Note) This cable must be prepared by the user.

<Rectangular wave communication detector (linear scale, etc.) cable connection diagram>



(Note) This cable must be prepared by the user.

<Serial communication detector (linear scale, etc.) cable connection diagram>



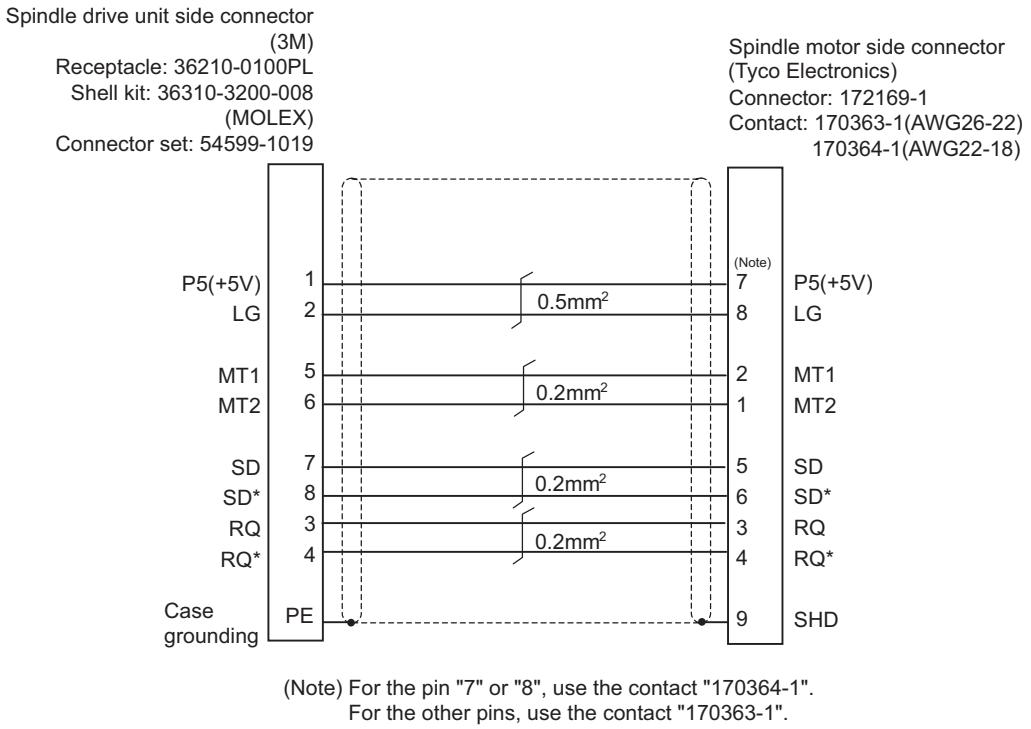
(Note) This cable must be prepared by the user.

POINT For compatible detector, refer to the section "Servo option" in Specifications Manual.

Appendix 1 Cable and Connector Specifications

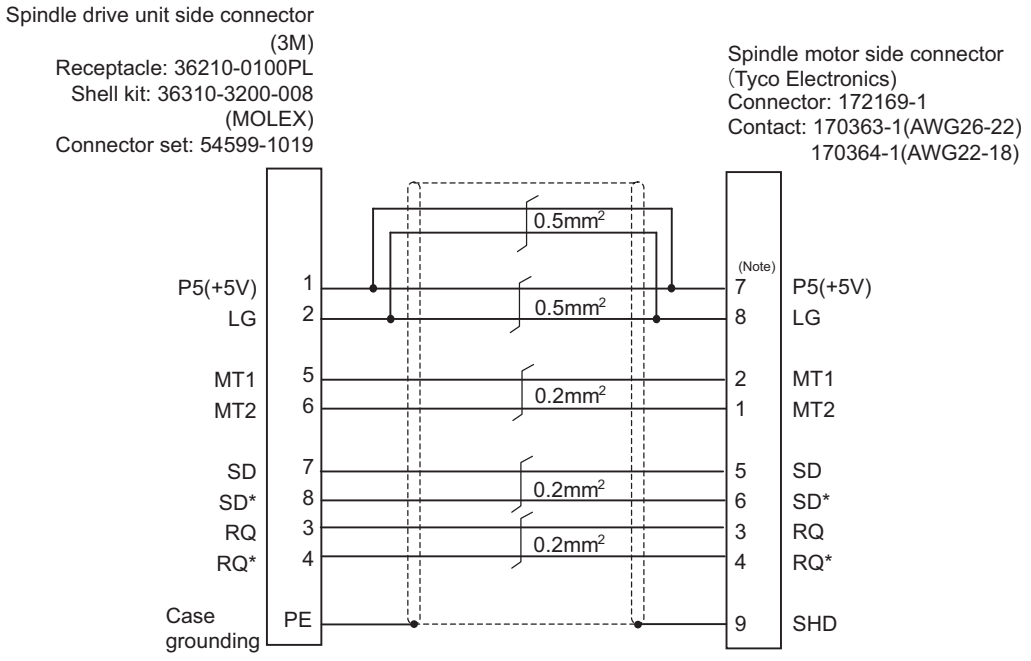
Appendix 1-2-4 Spindle detector cable

<CNP2E-1 cable connection diagram>



(Note) For the pin "7" or "8", use the contact "170364-1".
For the other pins, use the contact "170363-1".

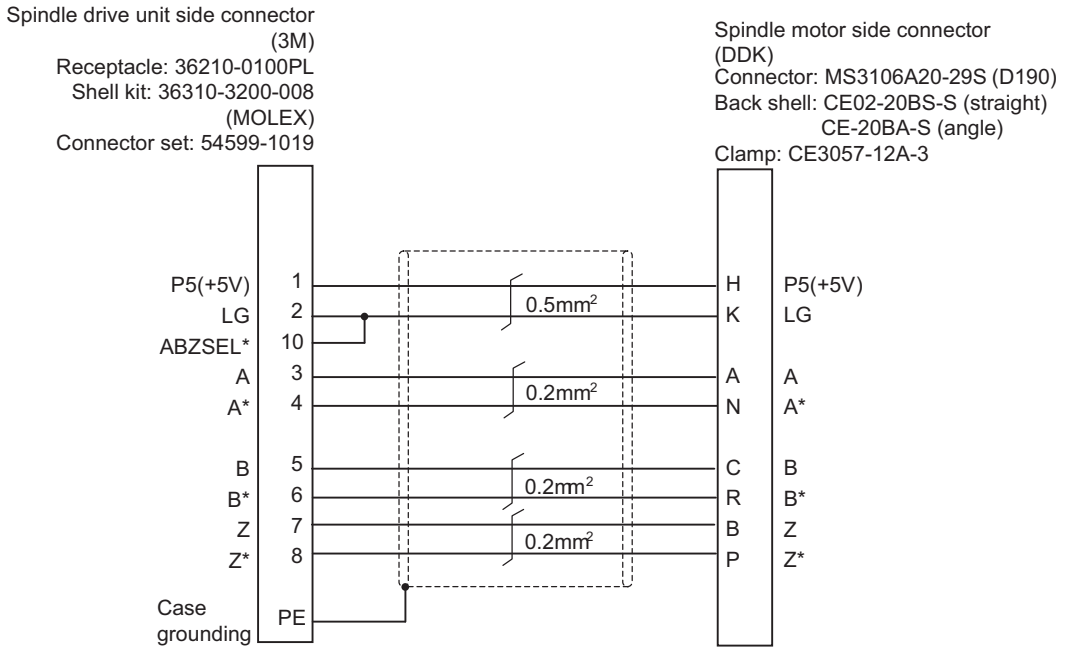
<For 15m or less>



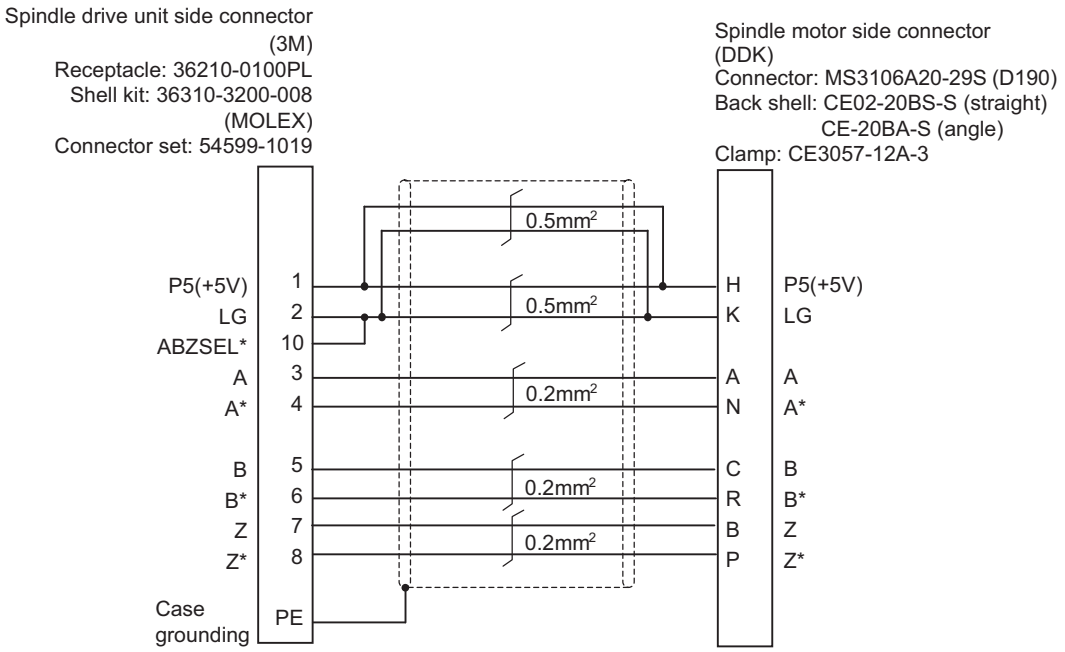
(Note) For the pin "7" or "8", use the contact "170364-1".
For the other pins, use the contact "170363-1".

<For 15m to 30m>

<CNP3EZ-2P, CNP3EZ-3P cable connection diagram>



<For 15m or less>



<For 15m to 30m>

Appendix 1 Cable and Connector Specifications

Appendix 1-3 Connector outline dimension drawings

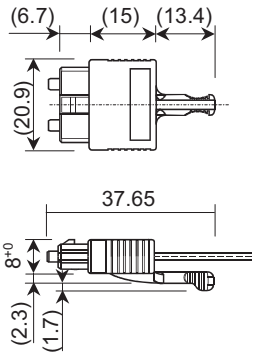
Appendix 1-3-1 Optical communication cable

For wiring between drive units (inside panel)

Optical communication connector

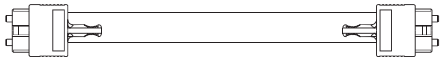
[Unit:mm]

Manufacturer: Japan Aviation Electronics Industry
<Type>
Connector:2F-2D103



(L≦0.1m)

Cable appearance
<Type>
Connector: 2F-2D103 (Japan Aviation Electronics Industry)
Optical fiber: ESKA Premium (MITSUBISHI RAYON)



(L≧0.2m)

(Note 1) The POF fiber's light amount will drop depending on how the fibers are wound. So, try to avoid wiring the fibers.

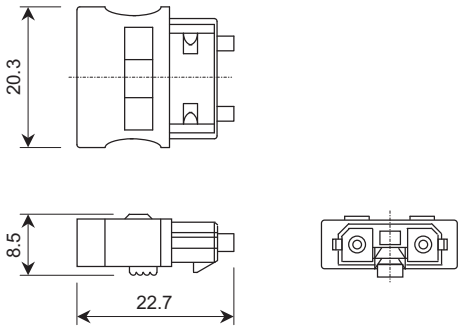
(Note 2) Do not wire the optical fiber cable to moving sections.

For wiring between drive units (outside panel)

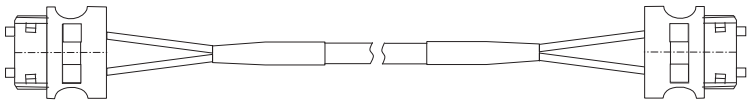
Optical communication connector

[Unit:mm]

Manufacturer: Tyco Electronics
<Type>
Connector: 1123445-1



Cable appearance
<Type>
Connector: 1123445-1
(Tyco Electronics)
Optical fiber: ESKA Premium
(MITSUBISHI RAYON)



(Note 1) The PCF fiber's light amount will drop depending on how the fibers are wound. So, try to avoid wiring the fibers.

(Note 2) Do not wire the optical fiber cable to moving sections.

For wiring between NC and drive unit

Refer to the instruction manual for CNC.

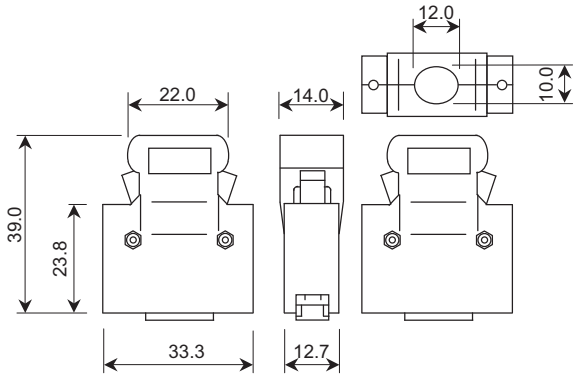
Appendix 1 Cable and Connector Specifications

Appendix 1-3-2 DI/O or maintenance connector

Connector for CN4/9

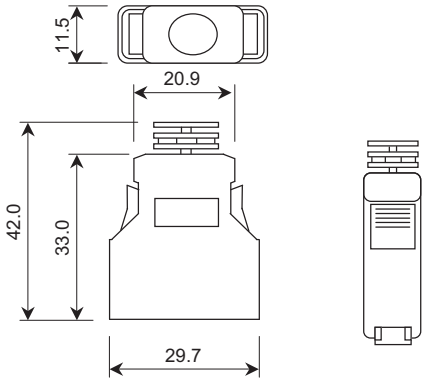
[Unit:mm]

Manufacturer: 3M
<Type>
Connector: 10120-3000VE
Shell kit: 10320-52F0-008



[Unit:mm]

Manufacturer: 3M
<Type>
Connector: 10120-6000EL
Shell kit:10320-3210-000
This connector is integrated with the cable, and is not available as a connector set option.

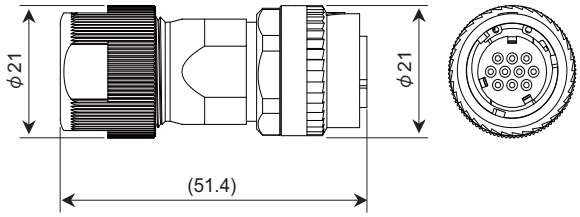


Appendix 1-3-3 Servo detector connector

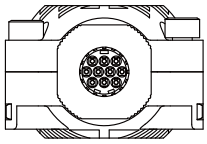
Motor side detector connector / Ball screw side detector for connector

[Unit:mm]

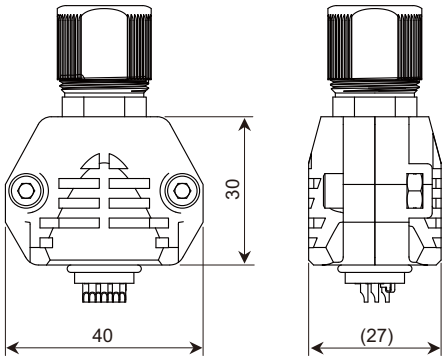
Manufacturer: DDK
<Type>
Plug:CM10-SP10S-M(D6)



[Unit:mm]



Manufacturer: DDK
<Type>
Reinforcing cover for straight plug:
CM10-SP-CV



(Note 1) For the manufacturing method of CM10 series connector, refer to the section "Cable and connector assembly" in Instruction Manual.

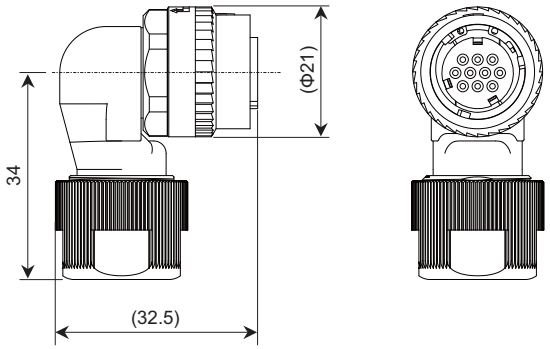
(Note 2) Use the reinforcing cover if thumping vibration and strong impacts could be applied on the connector.

Appendix 1 Cable and Connector Specifications

Motor side detector connector / Ball screw side detector for connector

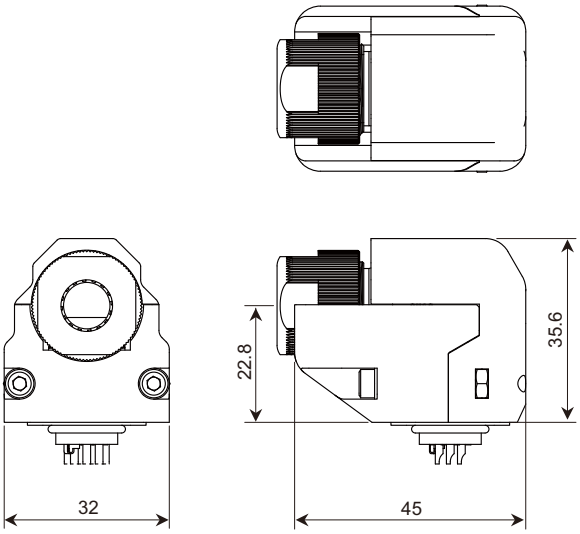
[Unit:mm]

Manufacturer: DDK
<Type>
Plug:CM10-AP10S-M(D6)



[Unit:mm]

Manufacturer: DDK
<Type>
Reinforcing cover for angle plug:
CM10-AP-D-CV



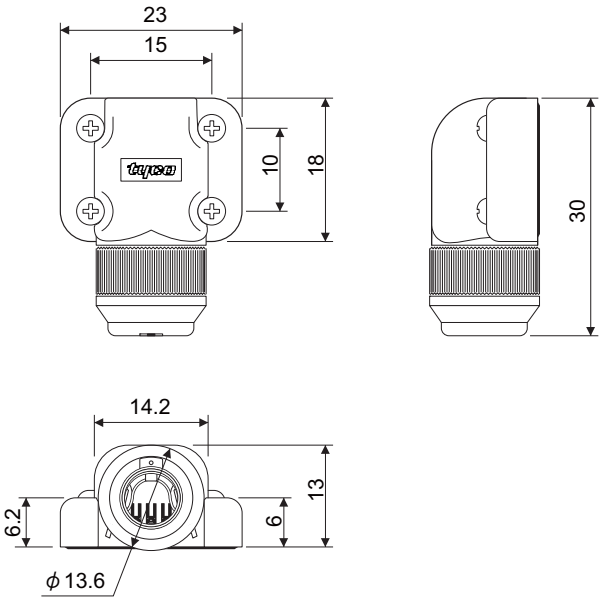
(Note 1) For the manufacturing method of CM10 series connector, refer to the section "Cable and connector assembly" in Instruction Manual.

(Note 2) Use the reinforcing cover if thumping vibration and strong impacts could be applied on the connector.

Motor side detector connector

[Unit:mm]

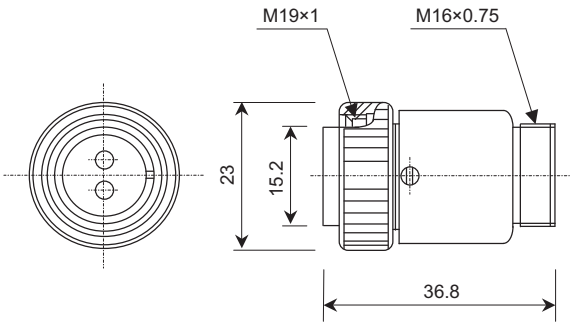
Manufacturer: Tyco Electronics
<Type>
Assembly: 1674320-1



MDS-B-HR connector

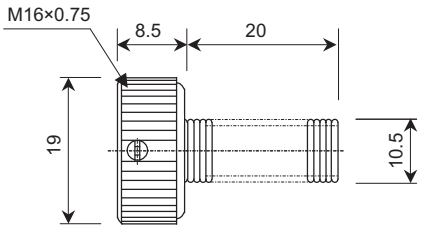
[Unit:mm]

Manufacturer: Hirose Electric
<Type>
Plug:
RM15WTP-8S (for CON1,2)
RM15WTP-12P (for CON3)



[Unit:mm]

Manufacturer: Hirose Electric
<Type>
Clamp: RM15WTP-CP(10)

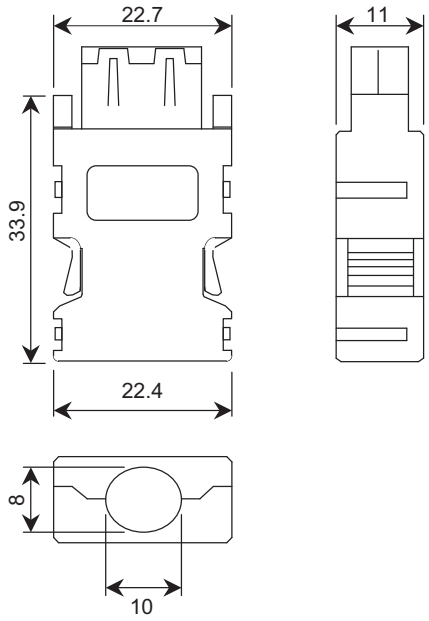


Appendix 1 Cable and Connector Specifications

Drive unit connector for CN2/3

[Unit:mm]

Manufacturer: 3M
<Type>
Receptacle: 36210-0100PL
Shell kit: 36310-3200-008
Manufacturer: MOLEX
<Type>
Connector set:54599-1019

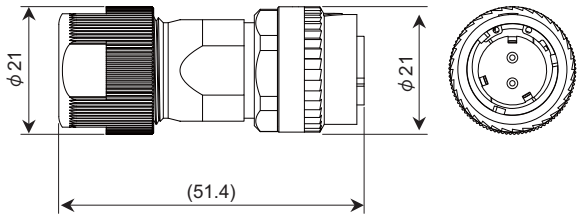


Appendix 1-3-4 Brake connector

Brake connector

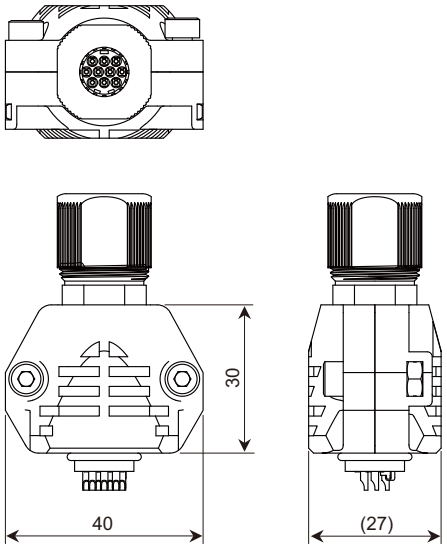
[Unit:mm]

Manufacturer: DDK
<Type>
Plug: CM10-SP2S-S(D6)



[Unit:mm]

Manufacturer: DDK
<Type>
Reinforcing cover for straight plug:
CM10-SP-CV



(Note 1) For the manufacturing method of CM10 series connector, refer to the section "Cable and connector assembly" in Instruction Manual.

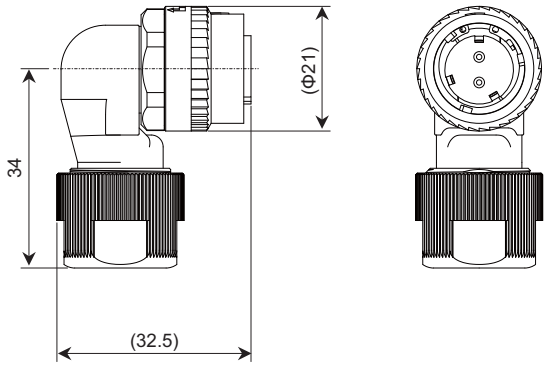
(Note 2) Use the reinforcing cover if thumping vibration and strong impacts could be applied on the connector.

Appendix 1 Cable and Connector Specifications

Brake connector

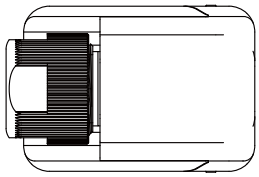
[Unit:mm]

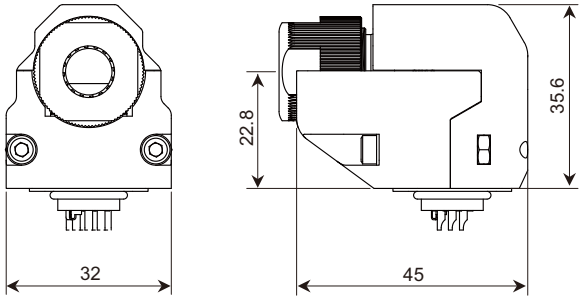
Manufacturer: DDK
<Type>
Plug: CM10-AP2S-S(D6)



[Unit:mm]

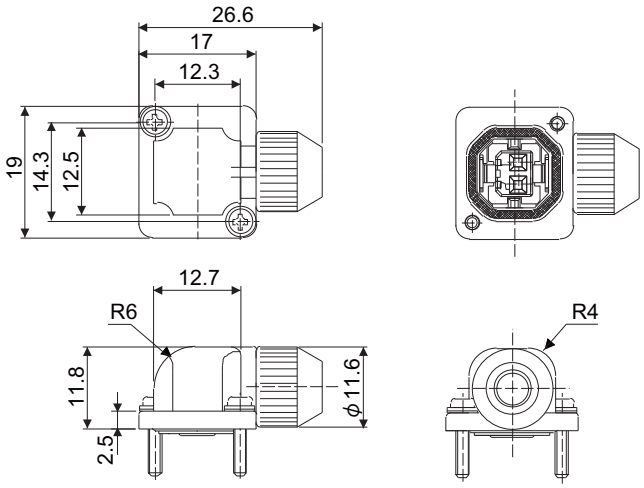
Manufacturer: DDK
<Type>
Reinforcing cover for angle plug:
CM10-AP-D-CV





[Unit:mm]

Manufacturer: Japan Aviation Electronics Industry
<Type>
JN4FT02SJ1-R



(Note 1) For the manufacturing method of CM10 series connector, refer to the section "Cable and connector assembly" in Instruction Manual.

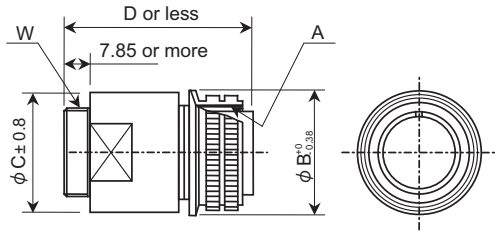
(Note 2) Use the reinforcing cover if thumping vibration and strong impacts could be applied on the connector.

Appendix 1-3-5 Power connector

Motor power connector

[Unit:mm]

Manufacturer: DDK

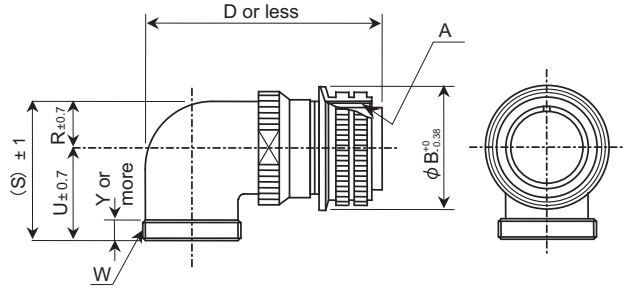


Plug:

Type	A	B +0 -0.38	C±0.8	D or less	W
CE05-6A18-10SD-C-BSS	$1^{1}/_{8}$-18UNEF-2B	34.13	32.1	57	1-20UNEF-2A
CE05-6A22-22SD-C-BSS	$1^{3}/_{8}$-18UNEF-2B	40.48	38.3	61	$1^{3}/_{16}$-18UNEF-2A

[Unit:mm]

Manufacturer: DDK

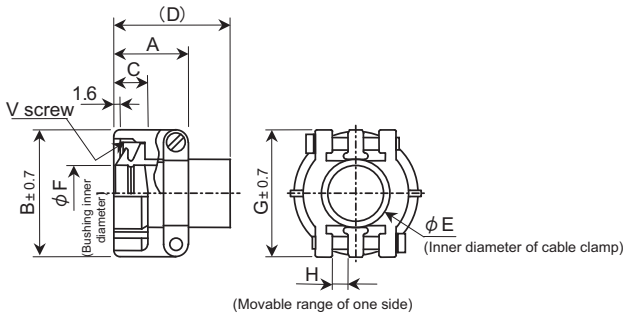


Plug:

Type	A	B +0 -0.38	D or less	W	R±0.7	U±0.7	(S)±1	Y or more
CE05-8A18-10SD-C-BAS	$1^{1}/_{8}$-18UNEF-2B	34.13	69.5	1-20UNEF-2A	13.2	30.2	43.4	7.5
CE05-8A22-22SD-C-BAS	$1^{3}/_{8}$-18UNEF-2B	40.48	75.5	$1^{3}/_{16}$-18UNEF-2A	16.3	33.3	49.6	7.5

[Unit:mm]

Manufacturer: DDK



Clamp:

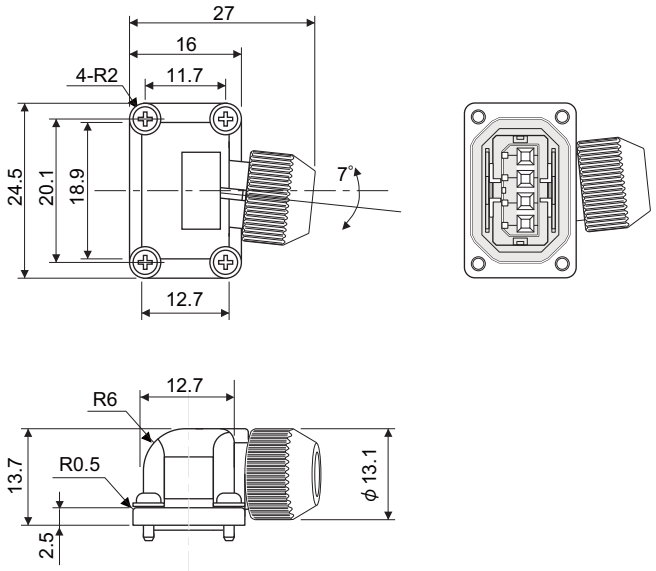
Type	Shell size	Total length A	Outer dia. B	Avail. screw length C	D	E	F	G	H	Fitting screw V	Bushing	Applicable cable
CE3057-10A-1(D240)	18	23.8	30.1	10.3	41.3	15.9	14.1	31.7	3.2	1-20UNEF-2B	CE3420-10-1	φ10.5 to φ14.1
CE3057-12A-1(D240)	20	23.8	35	10.3	41.3	19	16.0	37.3	4	$1^{3}/_{16}$-18UNEF-2B	CE3420-12-1	φ12.5 to φ16.0

Appendix 1 Cable and Connector Specifications

Motor power connector

[Unit:mm]

Manufacturer: Japan Aviation Electronics Industry
<Type>
JN4FT04SJ1-R

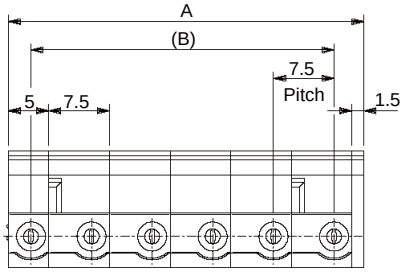


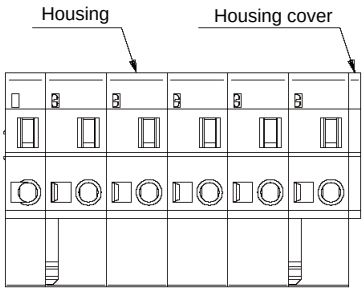
Appendix 1-3-6 Drive unit side main circuit connector

Drive unit CNP1 connector (for power supply), CNP3 connector (for motor power)

[Unit:mm]

Manufacturer: MOLEX

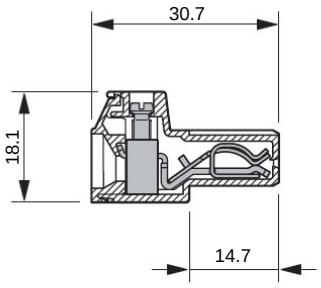


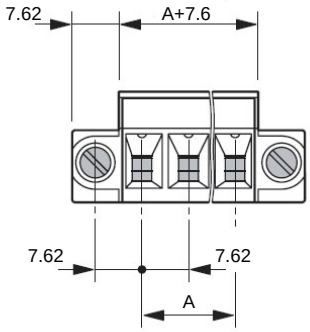


Type	A	B	No. of poles
54928-0670	44	37.5	6 (for CNP1)
54928-0370	21.5	15	3 (for CNP3)

[Unit:mm]

Manufacturer: Phoenix contact

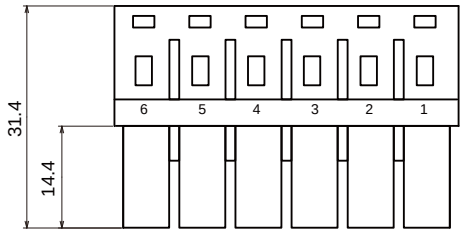


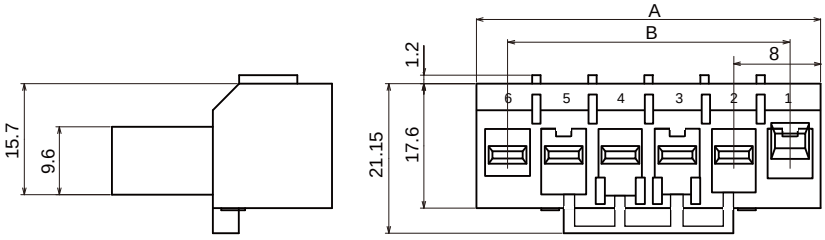


Type	A	No. of poles
PC4/6-STF-7.62-CRWH	38.10	6 (for CNP1)
PC4/3-STF-7.62-CRWH	15.24	3 (for CNP3)

[Unit:mm]

Manufacturer: J.S.T.





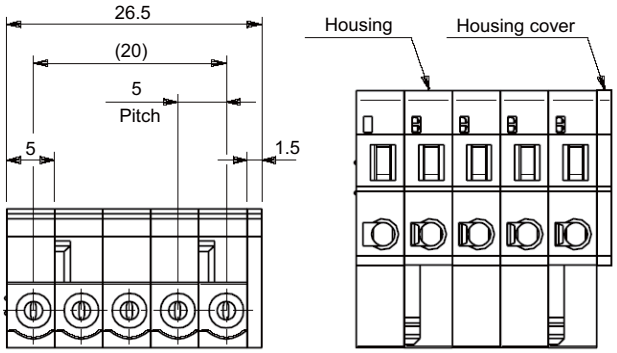
Type	A	B	No. of poles
06JFAT-SAXGFS-XL	49.1	40	6 (for CNP1)
03JFAT-SAXGFS-XL	25.1	16.0	3 (for CNP3)

Appendix 1 Cable and Connector Specifications

Drive unit CNP2 connector (for control power)

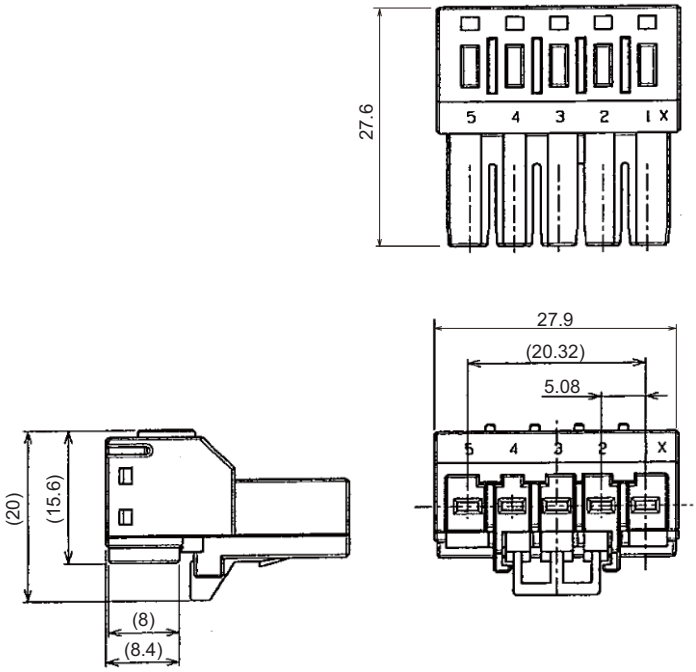
[Unit:mm]

Manufacturer: MOLEX
<Type>
Connector:54927-0520



[Unit:mm]

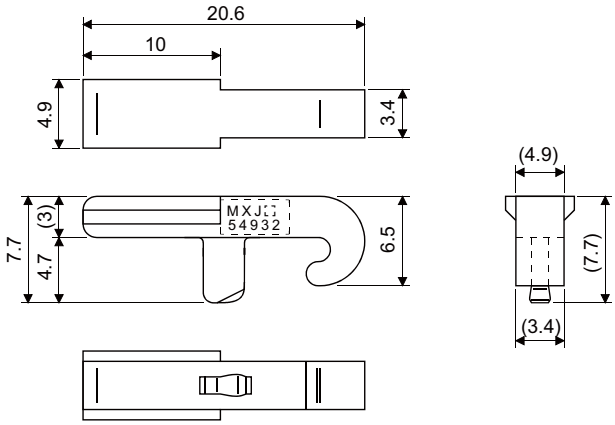
Manufacturer: J.S.T.
<Type>
Connector:05JFAT-SAXGSA-E-SS



Connection lever for drive unit

[Unit:mm]

Manufacturer: MOLEX
<Type>
Connector:54932-0000

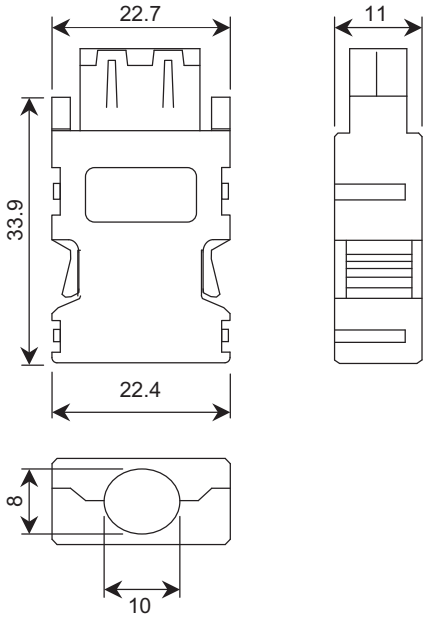


Appendix 1-3-7 Spindle detector connector

Spindle drive unit Connector for CN2/3

[Unit:mm]

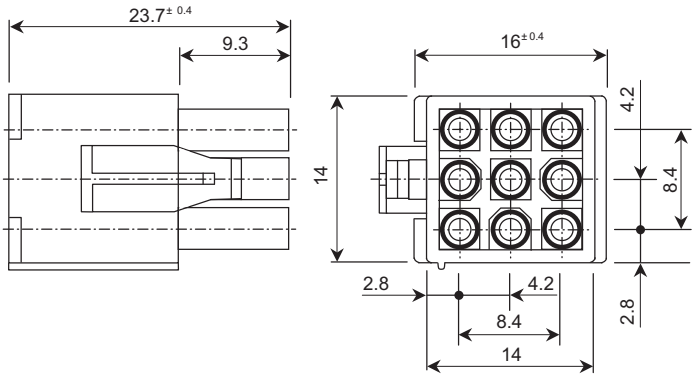
Manufacturer: 3M
<Type>
Receptacle: 36210-0100PL
Shell kit: 36310-3200-008
Manufacturer: MOLEX
<Type>
Connector set: 54599-1019



Motor side PLG (TS5690) connector

[Unit:mm]

Manufacturer: Tyco Electronics
<Type>
Plug: 172169-1

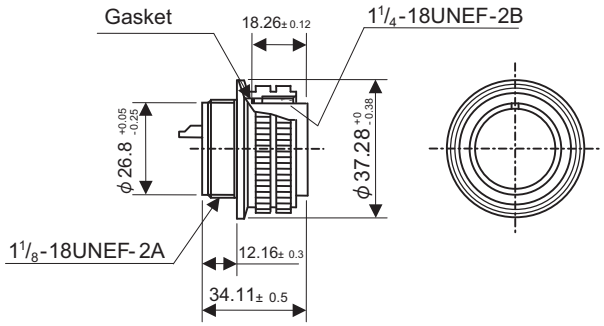


Appendix 1 Cable and Connector Specifications

Spindle side detector connector (for OSE-1024)

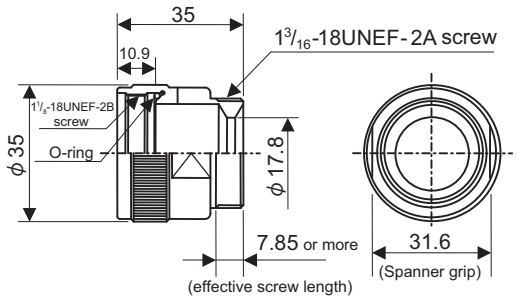
[Unit:mm]

Manufacturer: DDK
<Type>
Connector: MS3106A20-29S(D190)



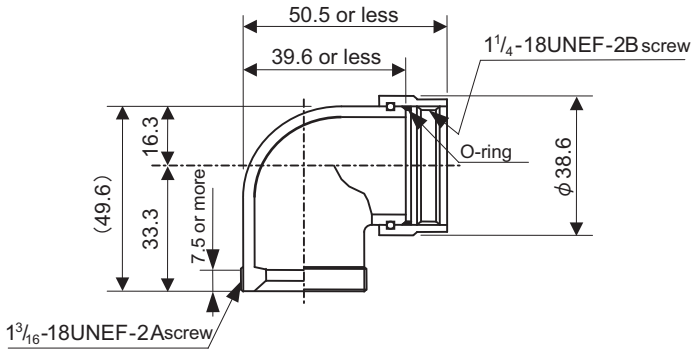
[Unit:mm]

Manufacturer: DDK
<Type>
Straight back shell: CE02-20BS-S



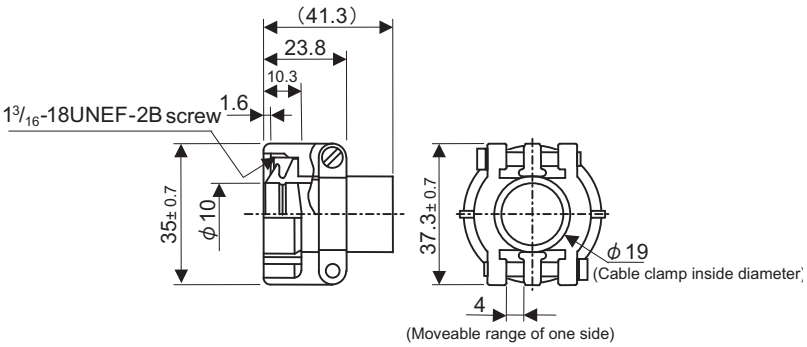
[Unit:mm]

Manufacturer: DDK
<Type>
Angle back shell: CE-20BA-S



[Unit:mm]

Manufacturer: DDK
<Type>
Cable clamp:CE3057-12A-3



Appendix 2

Restrictions for Lithium Batteries

Contents

Appendix 2 Restrictions for Lithium Batteries

Appendix 2-1 Restriction for Packing

The United Nations Dangerous Goods Regulations "Article 12" became effective from 2003. When transporting lithium batteries with means subject to the UN Regulations, such as by air transport, measures corresponding to the Regulations must be taken.
The UN Regulations classify the batteries as dangerous goods (Class 9) or not dangerous goods according to the lithium metal content. To ensure safety during transportation, lithium batteries (battery unit) directly exported from Mitsubishi are packaged in a dedicated container (UN package) for which safety has been confirmed.
When the customer is transporting these products with means subject to the UN Regulations, such as air transport, the shipper must follow the details explained in the section "Transportation Restrictions for Lithium Batteries: Handling by User".
The followings are restrictions for transportation. Each restriction is specified based on the recommendation of the United Nations.

Area	Transportation method	Restriction	Special clause
World	Air	ICAO, IATA	-
World	Marine	IMO	188
United States	All (air, marine, land)	DOT	49 CFR 173.185
Europe	land	RID, ADR	188

Appendix 2-1-1 Target Products

The following Mitsubishi NC products use lithium batteries. If the lithium metal content exceeds 1g for battery cell and 2g for battery, the battery is classified as dangerous good (Class9).
In order to avoid an accidental actuation during the transportation, all lithium battery products incorporated in a machinery or device must be fixed securely and must be shipped with wrapped over the outer package as to prevent damage or short-circuits.

(1) Materials falling under Class 9

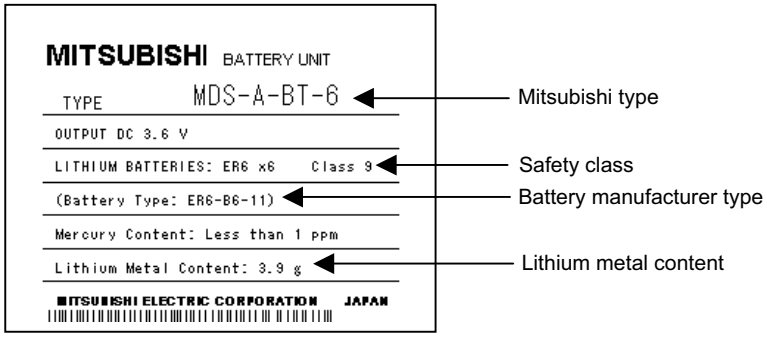
Mitsubishi type (Type for arrangement)	Battery type	Lithium metal content	Number of incorporated ER6V batteries	Application (Data backup)	Battery class	Outline dimension drawing
MDS-A-BT-4	ER6-B4-11	2.6g	4 batteries	For servo detector	Battery	For servo, refer to the section "Battery option" in MDS-D/DH Series Instruction Manual.
MDS-A-BT-6	ER6-B6-11	3.9g	6 batteries	For servo detector		
MDS-A-BT-8	ER6-B8-11	5.2g	8 batteries	For servo detector		
FCU6-BT4-D1	Combination of ER6-B4D-11 and ER6V battery cell	2.6g+0.65g	5 batteries	For servo detector/ NC SRAM		
CR23500SE-CJ5	CR23500SE-CJ5	1.52g	-	For NC SRAM (M500)	Battery cell	

(2) Materials not falling under Class 9

Mitsubishi type (Type for arrangement)	Battery type	Lithium metal content	Number of incorporated ER6V batteries	Application (Data backup)	Battery class	Outline dimension drawing
MDS-A-BT-2	ER6-B2-12	1.3g	2 batteries	For servo detector	Battery	For servo, refer to the section "Battery option" in MDS-D/DH Series Instruction Manual.
FCU6-BTBOX series	2CR5	1.96g	-	For NC SRAM/ servo detector		
CR2032 (for built-in battery)	CR2032	0.067g	-	For NC SRAM/	Battery cell	
CR2450 (for built-in battery)	CR2450	0.173g	-	For NC SRAM		
ER6, ER6V series (for built-in battery)	ER6, ER6V	0.65g	-	For NC SRAM/ servo detector		
A6BAT(MR-BAT)	ER17330V	0.48g	-	For servo detector		
Q6BAT	Q6BAT	0.49g	-	For NC SRAM		
MR-J3BAT	ER6V	0.65g	-	For servo detector		

(Note) If the number of batteries exceeds 24 batteries for the battery cell or 12 batteries for the battery, the dedicated packing (for materials falling under Class 9) is required.

(Example) Rating nameplate for battery units



Appendix 2 Restrictions for Lithium Batteries

Appendix 2-1-2 Handling by User

The following technical opinion is solely Mitsubishi's opinion. The shipper must confirm the latest IATA Dangerous Goods Regulations, IMDG Codes and laws and orders of the corresponding export country. These should be checked by the company commissioned for the actual transportation.

IATA: International Air Transport Association

IMDG Code: A uniform international code for the transport of dangerous goods by seas determined by IMO (International Maritime Organization).

■ **When shipping isolated lithium battery products**

(1) Reshipping in Mitsubishi UN packaging (Class 9)

Mitsubishi packing applies package specifications complying with the UN Packing Instruction. The user only needs to add the following details before shipping. (Consult with the shipping company for details.)

(a) Indication of container usage mark on exterior box (Label with following details recorded.)

[1] Proper shipping name (Lithium batteries)

[2] UN NO. (UN3090 for isolated battery, UN3091 for battery incorporated in a device or included)

[3] Shipper and consignee's address and name

Example of completing form

SHIPPER: CONSIGNEE:

Shipper information Consignee information

PROPER SHIPPING NAME LITHIUM BATTERIES

UN NO.: UN3090 CLASS: 9 SUBSIDIARY RISK

PACKING GROUP: II PACKING INST.: 903

[4] A care label with a telephone number for additional information (120×110mm)

(A care label is to be attached on the outer package.Shipping less than or equal to 4 isolated batteries incorporated in machinery does not need care label.)

Lithium battery care label (Air transportation sample)

(b) Preparation of shipping documents and declaration of dangerous goods
For information required in description, refer to "Appendix2-2 Product information data sheet".

(2) When packaged by user
The user must follow UN Regulations when packing, preparing for shipping and preparing the indications, etc.
(a) Packing a lithium battery falling under Class 9
[1] Consult with The Ship Equipment Inspection Society of Japan for details on packaging.
[2] Prepare for shipping as explained in "(1) Reshipping in Mitsubishi UN packaging".
The Ship Equipment Inspection Society of Japan Headquarters Telephone: 03-3261-6611 Fax: 03-3261-6979
(b) Packing a lithium battery not falling under Class 9
[1] Cells and batteries are separated so as to prevent short circuits and are stored in a strong outer packaging (12 batteries or less, 24 battery cells or less).
[2] Prepare for the certificates or test results showing compliance to drop test from 1.2m in height. (The safety test results have been obtained from the battery manufacturer. Consult with Mitsubishi when the safety test results are required.)
[3] Prepare for shipping as explained in "(1) Reshipping in Mitsubishi UN packaging (Class 9)".

■ **When shipping lithium batteries incorporating in a device or machinery**
Dedicated packaging (UN packaging) is not required for batteries incorporated in device or machinery. Yet, make sure to fix the contents securely before the transportation as to prevent damage and short-circuit.
If machinery and devices which incorporates lithium battery is not waterproof, package must be waterproof material.
Check with your shipping company for details on packing and transportation.

Appendix 2-1-3 Reference

Refer to the following materials for details on the regulations and responses.
Guidelines regarding transportation of lithium batteries and lithium ion batteries (Edition 2)..... Battery Association of Japan

Appendix 2 Restrictions for Lithium Batteries

Appendix 2-2 Products information data sheet (ER battery)

MSDS system does not cover the product used in enclosed state. The ER battery described in this section applies to that product.
This description is applied to the normal use, and is provided as reference but not as guarantee.
This description is based on the lithium battery's (ER battery) hazardous goods data sheet (Products information data sheet) which MITSUBISHI has researched, and will be applied only to the ER batteries described in "Transportation Restrictions for Lithium Batteries: Restriction for Packing".

(1) Outline of hazard

Principal hazard and effect	Not found.
Specific hazard	As the chemical substance is stored in a sealed metal container, the battery itself is not hazardous. But when the internal lithium metal attaches to human skin, it causes a chemical skin burn. As a reaction of lithium with water, it may ignite or forms flammable hydrogen gas.
Environmental effect	Not found.
Possible state of emergency	Damages or short-circuits may occur due to external mechanical or electrical pressures.

(2) First-aid measure

Inhalation	If a person inhales the vapor of the substance due to the battery damage, move the person immediately to fresh air. If the person feels sick, consult a doctor immediately.
Skin contact	If the content of the battery attaches to human skin, wash off immediately with water and soap. If skin irritation persists, consult a doctor.
Eye contact	In case of contact with eyes due to the battery damage, rinse immediately with a plenty of water for at least 15 minutes and then consult a doctor.
Ingestion	If swallowed, consult a doctor immediately.

(3) Fire-fighting measure

Appropriate fire-extinguisher	Dry sand, dry chemical, graphite powder or carbon dioxide gas
Special fire-fighting measure	Keep the battery away from the fireplace to prevent fire spreading.
Protectors against fire	Fire-protection gloves, eye/face protector (face mask), body/skin protective cloth

(4) Measure for leakage

Environmental precaution	Dispose of them immediately because strong odors are produced when left for a long time.
How to remove	Get them absorbed into dry sand and then collect the sand in an empty container.

(5) Handling and storage

Handling	**Cautions for safety handling**	Do not peel the external tube or damage it. Do not dispose of the battery in fire or expose it to heat. Do not immerse the battery in water or get it wet. Do not throw the battery. Do not disassemble, modify or transform the battery. Do not short-circuit the battery.
Storage	**Appropriate storage condition**	Avoid direct sunlight, high temperature and high humidity. (Recommended temp. range: +5 to +35C°, humidity: 70%RH or less)
	Material to avoid	Flammable or conductive material (Metal: may cause a short-circuit)

(6) Physical/chemical properties

Appearance	**Physical form**	Solid
	Shape	Cylinder type
	Smell	Odorless
	pH	Not applicable (insoluble)
	Boiling point/Boiling range, Melting point, Decomposition temperature, Flash point	No information

(7) Stability and reactivity

Stability	Stable under normal handling condition.
Condition to avoid	Do not mix multiple batteries with their terminals uninsulated. This may cause a short-circuit, resulting in heating, bursting or ignition.
Hazardous decomposition products	Irritative or toxic gas is emitted in the case of fire.

(8) Toxicological information

As the chemical substance is stored in a sealed metal container, the battery has no harmfulness. Just for reference, the table below describes the main substance of the battery.

< Lithium metal >

Acute toxicity	No information
Local effect	Corrosive action in case of skin contact

< Thionyl chloride >

Acute toxicity	Lc_{50}: 500ppm (inhaled administration to rat)
Local effect	The lungs can be damaged by chronic cough, dyspnea and asthma.

< Aluminum chloride >

Acute toxicity	L_{D50}: 3700ppm (oral administration to rat)
Local effect	Not found.

< Lithium chloride >

Acute toxicity	L_{D50}: 526ppm (oral administration to rat)
Local effect	The central nerves and kidney can be influenced.

< Carbon black >

Acute toxicity	L_{D50}: 2,000mg/kg > (rat)
Carcinogenicity	LARC group 2 (suspected of being carcinogenic)

(9) Ecological information

Mobility, Persistence/Decomposability, Bio-accumulation potential, Ecological toxicity	Not found.

(10) Caution for disposal

Dispose of the battery following local laws or regulations.

Pack the battery properly to prevent a short-circuit and avoid contact with water.

Appendix 2-3 Issuing Domestic Law of the United States for Primary Lithium Battery Transportation

Federal Aviation Administration (FAA) and Research and Special Programs Administration (RSPA) announced an additional regulation (interim final rule) for the primary lithium batteries transportation restrictions item in "Federal Register" on Dec.15 2004.
This regulation became effective from Dec.29, 2004. This law is a domestic law of the United States, however if also applies to the domestic flight and international flight departing from or arriving in the United States. Therefore, when transporting lithium batteries to the United State, or within the United State, the shipper must take measures required to transport lithium batteries. Refer to the Federal Register and the code of Federal Regulation ("Transportation Restrictions for Lithium Batteries: Reference") for details.

Appendix 2-3-1 Outline of Regulation

(1) Transporting primary lithium battery by passenger aircraft is forbidden.
  (a) Excluding primary lithium battery for personal use in a carry-on or checked luggage (Lithium metal content should be not more than 5g for cell and 25g for battery. For details on the lithium metal content, refer to "Transportation Restrictions for Lithium Batteries: Target Products".)
(2) When transporting primary lithium battery by cargo aircraft, indicate that transportation by passenger aircraft is forbidden on the exterior box.

Appendix 2-3-2 Target Products

All NC products for which the lithium batteries are used are subject to the regulation.
(Refer to the table "Transportation Restrictions for Lithium Batteries: Target Products".)

Appendix 2-3-3 Handling by User

The "Transportation Restrictions for Lithium Batteries: Outline of Regulation" described above is solely Mitsubishi's opinion. The shipper must confirm orders of "Transportation Restrictions for Lithium Batteries: Reference" described below for transportation method corresponding the regulation.
These should be checked by the company commissioned for the actual lithium battery transportation.

(1) Indication of exterior box

When transporting primary lithium battery by cargo aircraft, indicate that transportation by passenger aircraft is forbidden on the exterior box.

Display example

PRIMARY LITHIUM BATTERIES **FORBIDDEN FOR TRANSPORT ABOARD PASSENGER AIRCRAFT.**

  (a) The character color must be displayed with contrast. (black characters against white background, black characters against yellow background, etc.)
  (b) The height (size) of characters to be displayed is prescribed depending on the packaging mass. (When the total mass is over 30kg: at least 12mm, When the total mass is less than 30kg: at least 6mm)

Appendix 2-3-4 Reference

(1) 49CFR (Code of Federal Regulation, Title49) (173.185 Lithium batteries and cells.)
http://www.access.gpo.gov/nara/cfr/waisidx_00/49cfr173_00.html
(2) DOT regulation body (Department of Transportation)
http://hazmat.dot.gov/regs/rules/final/69fr/docs/69fr-75207.pdf

Appendix 2-4 Restriction related to EU Battery Directive

EU Battery Directive (2006/66/EC) has been enforced since September 26th in 2008. Hereby, battery and machinery incorporating battery marketed in European Union countries must be in compliance with the EU Battery Directive.
Lithium battery provided by MITSUBISHI are subjected to this restriction.

Appendix 2-4-1 Important Notes

Follow the instruction bellow as shipping products incorporating MITSUBISHI device.
(1) When shipping products incorporating MITSUBISHI device any time later than September 26th, 2008, the symbol mark shown as Figure 1 in section "Information for end-user" is required to be attached on the machinery or on the package. Also, the explanation of the symbol must be added.
(2) Machinery with battery and maintenance battery produced before the EU Battery Directive are also subjected to the restriction. When shipping those products to EU countries later than September 26th, 2008, follow the instruction explained in (1).

Appendix 2-4-2 Information for end-user

Figure 1

Note: This symbol mark is for EU countries only.
This symbol mark is according to the directive 2006/66/EC Article 20 Information for end-users and Annex II.
Your MITSUBISHI ELECTRIC product is designed and manufactured with high quality materials and components which can be recycled and/or reused. This symbol means that batteries and accumulators, at their end-of-life, should be disposed of separately from your household waste.
If a chemical symbol is printed beneath the symbol shown above, this chemical symbol means that the battery or accumulator contains a heavy metal at a certain concentration. This will be indicated as follows:Hg: mercury (0,0005%), Cd: cadmium (0,002%), Pb: lead (0,004%)
In the European Union there are separate collection systems for used batteries and accumulators. Please, dispose of batteries and accumulators correctly at your local community waste collection/recycling centre.
Please, help us to conserve the environment we live in!

Appendix 3

Compliance to EC Directives

Contents

Appendix 3 Compliance to EC Directives

Appendix 3-1 Compliance to EC Directives

Appendix 3-1-1 European EC Directives

In the EU Community, the attachment of a CE mark (CE marking) is mandatory to indicate that the basic safety conditions of the Machine Directives (issued Jan. 1995), EMC Directives (issued Jan. 1996) and the Low-voltage Directives (issued Jan. 1997) are satisfied. The machines and devices in which the servo and spindle drive are assembled are the targets for CE marking.

(1) Compliance to EMC Directives

The servo and spindle drive are components designed to be used in combination with a machine or device. These are not directly targeted by the Directives, but a CE mark must be attached to machines and devices in which these components are assembled. The next section "EMC Installation Guidelines", which explains the unit installation and control panel manufacturing method, etc., has been prepared to make compliance to the EMC Directives easier.

(2) Compliance to Low-voltage Directives

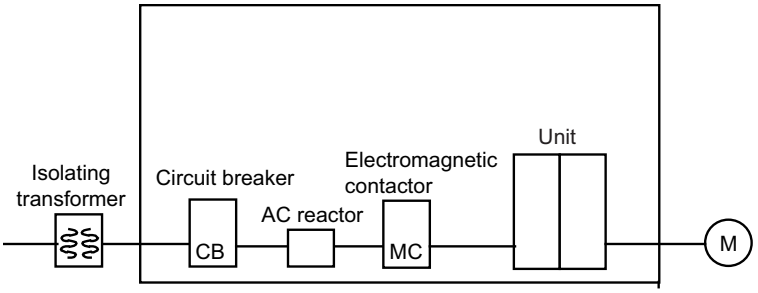
Each unit is targeted for the Low-voltage Directives. An excerpt of the precautions given in this specification is given below. Please read this section thoroughly before starting use.

For the EMC Directives and Low-voltage Directives, Self-Declaration Documents has been prepared. Contact Mitsubishi or your dealer when required.

Appendix 3-1-2 Cautions for EC Directive compliance

Use the Low-voltage Directive compatible parts for the servo/spindle drive and servo/spindle motor. In addition to the items described in this instruction manual, observe the items described below.

(1) Configuration



Insert a type B circuit breaker (RCD) in the power supply side of the unit.

(2) Environment

Use the units under an Overvoltage II (MDS-D, MDS-D-SVJ3/SPJ3) and Pollution Class of 2 or less environment as stipulated in IEC60664.

(a) To adjust the units to the Overvoltage Category II, insert an isolating transformer of the star connection complying with EN or IEC standard in the input of the power supply unit.

(b) To adjust the units to the Pollution Class of 2, install the units in a control panel having a structure (IP54 or higher) in which water, oil, carbon or dust cannot enter.

Unit

	During operation	Storage	During transportation
Ambient temperature	0°Cto 55°C	-15°C to 70°C	-15°C to 70°C
Humidity	90%RH or less	90%RH or less	90%RH or less
Altitude	1000m or less	1000m or less	13000m or less

Motor

	During operation	Storage	During transportation
Ambient temperature	0°C to 40°C	-15°C to 70°C	-15°C to 70°C
Humidity	80%RH or less	90%RH or less	90%RH or less
Altitude	1000m or less	1000m or less	13000m or less

(3) Power supply

[1] Use the power supply and servo/spindle drive unit under an Overvoltage Category II (MDS-D, MDS-D-SVJ3/SPJ3) as stipulated in IEC60664.

[2] Earth the PE terminal of the units to the neutral point of the star connection.

[3] Do not omit the circuit breaker and electromagnetic contactor.

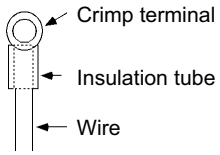
(4) Earthing

[1] To prevent electric shocks, always connect the servo/spindle drive unit protective earth (PE) terminal (terminal with ⏚ mark) to the protective earth (PE) on the control panel.

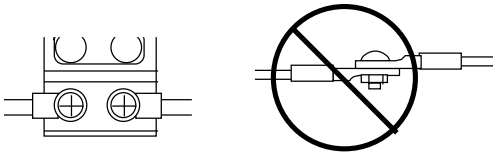
[2] When connecting the earthing wire to the protective earth (PE) terminal, do not tighten the wire terminals together. Always connect one wire to one terminal.

(5) Wiring

[1] Always use crimp terminals with insulation tubes so that the connected wire does not contact the neighboring terminals.



[2] Do not connect the wires directly.



[3] Always install the power supply unit and servo/spindle drive unit on the metal panel.

Appendix 3 Compliance to EC Directives

(6) Peripheral devices

[1] Use EN/IEC Standards compliant parts for the circuit protector and contactor.

[2] Select type B circuit protector manufactured by RCD.
Apply Annex C of EN60204-1 for sizing of the circuit protector.

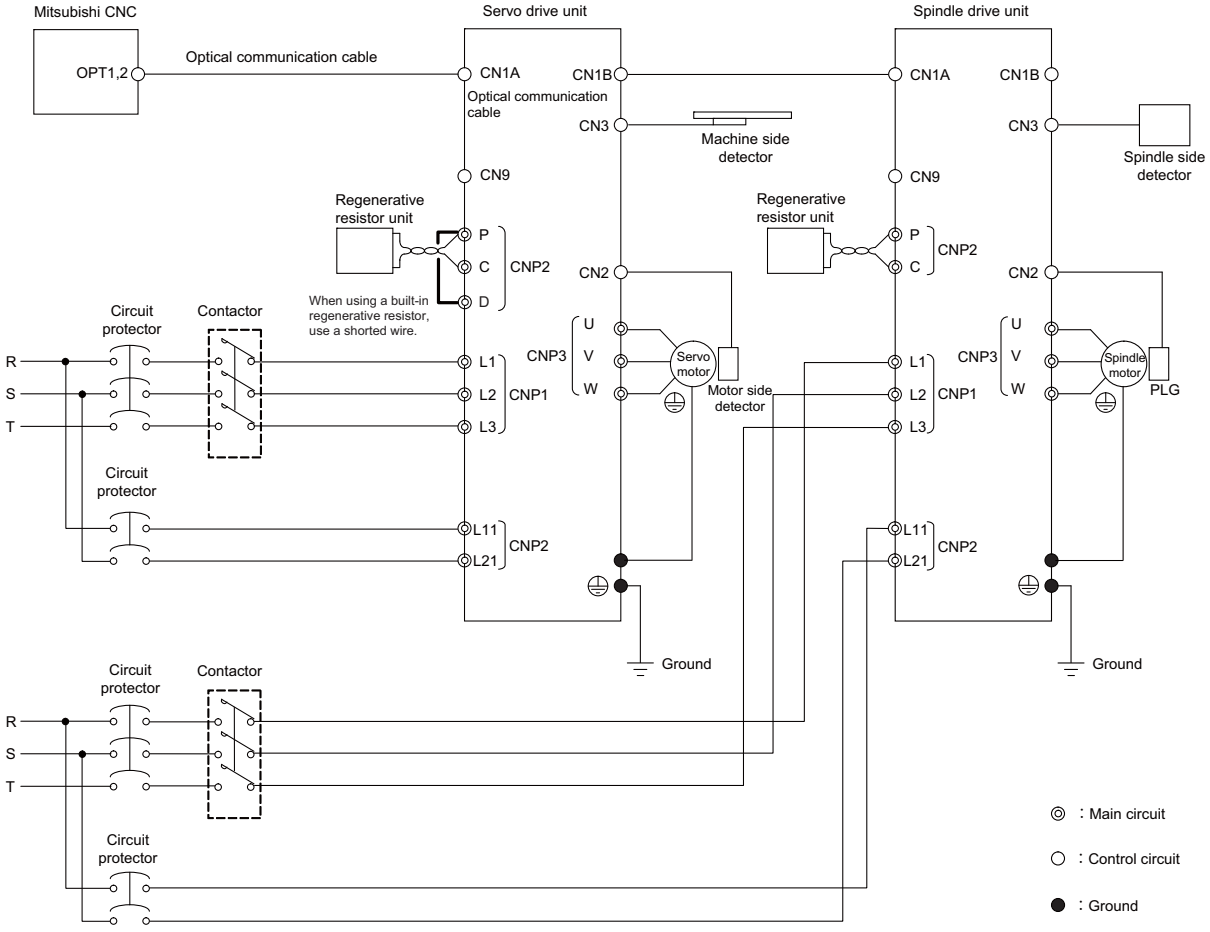
(7) Miscellaneous

[1] Refer to the next section "EMC Installation Guidelines" for methods on complying with the EMC Directives.

[2] Ground the facility according to each country's requirements.

[3] The control circuit connector (○) is safely separated from the main circuit (◎) and ground (●).

[4] Inspect the appearance before installing the unit. Carry out a performance inspection of the final unit, and save the inspection records.



Appendix 4

EMC Installation Guidelines

Contents

Appendix 4 EMC Installation Guidelines

Appendix 4-1 Introduction

EMC Instructions became mandatory as of January 1, 1996. The subject products must have a CE mark attached indicating that the product complies with the Instructions.
As the NC unit is a component designed to control machine tools, it is believed to be out of the direct EMC Instruction subject. However, we would like to introduce the following measure plans to backup EMC Instruction compliance of the machine tool as the NC unit is a major component of the machine tools.

[1] Methods for installation in control/operation panel
[2] Methods of wiring cable outside of panel
[3] Introduction of countermeasure parts

Mitsubishi is carrying out tests to confirm the compliance to the EMC Standards under the environment described in this manual. However, the level of the noise will differ according to the equipment type and layout, control panel structure and wiring lead-in, etc. Thus, we ask that the final noise level be confirmed by the machine manufacturer.
For measures for CNC, refer to "EMC INSTALLATION GUIDELINES" of each NC Connection Manual.

Appendix 4-2 EMC instructions

The EMC Instructions regulate mainly the following two withstand levels.

Emission ..... Capacity to prevent output of obstructive noise that adversely affects external sources.
Immunity ..... Capacity not to malfunction due to obstructive noise from external sources.

The details of each level are classified as Table 1. It is assumed that the Standards and test details required for a machine are about the same as these.

Table 1

Class	Name	Details	Generic Standard	Standards for determining test and measurement
Emission	Radiated noise	Electromagnetic noise radiated through the air	EN61000-6-4 EN61800-3 (Industrial environment)	-----
	Conductive noise	Electromagnetic noise discharged from power line		
Immunity	Static electricity electrical discharge immunity test	(Example) Withstand level of discharge of electricity charged in a human body.	EN61000-6-2 EN61800-3 (Industrial environment)	EN61000-4-2
	Radiated radio-frequency magnetic field immunity test	(Example) Simulation of immunity from digital wireless transmitters		EN61000-4-3
	Electrical fast transient/burst immunity test	(Example) Withstand level of noise from relays or connecting/disconnecting live wires		EN61000-4-4
	Immunity to conducted disturbance induced by radio-frequency magnetic field	(Example) Withstand level of noise entering through power line, etc.		EN61000-4-6
	Power supply frequency field immunity test	(Example) 50/60Hz power frequency noise		EN61000-4-8
	Immunity test for voltage dip, short-time power failure and voltage fluctuation	(Example) Power voltage drop withstand level		EN61000-4-11
	Surge immunity test	(Example) Withstand level of noise caused by lightning		EN61000-4-5

Appendix 4-3 EMC measures

The main items relating to EMC measures include the following.

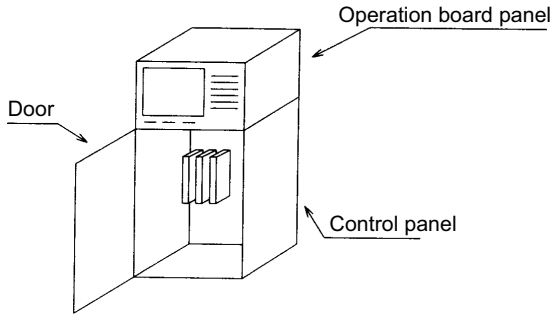
[1] Store the device in an electrically sealed metal panel.
[2] Earth all conductors that are floating electrically. (Lower the impedance.)
[3] Wire the power line away from the signal wire.
[4] Use shielded wires for the cables wired outside of the panel.
[5] Install a noise filter.

Ensure the following items to suppress noise radiated outside of the panel.

[1] Securely install the devices.
[2] Use shielded wires.
[3] Increase the panel's electrical seal. Reduce the gap and hole size.
Note that the electromagnetic noise radiated in the air is greatly affected by the clearance of the panel and the quality of the cable shield.

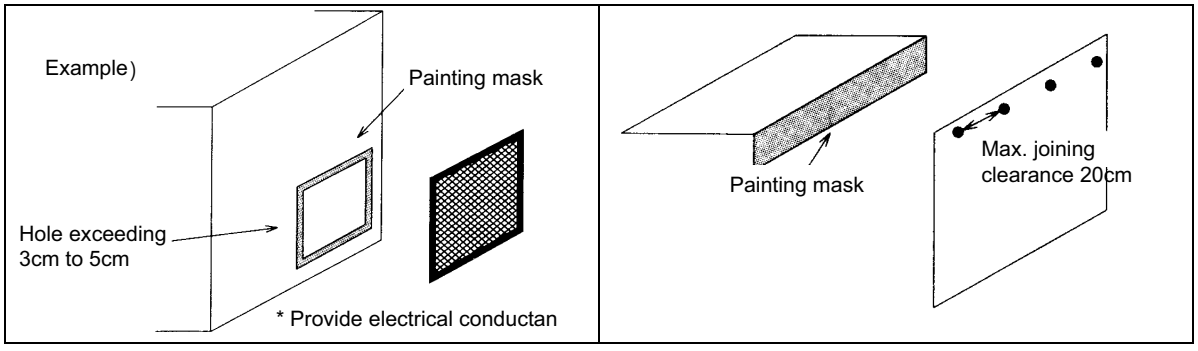
Appendix 4-4 Measures for panel structure

The design of the panel is a very important factor for the EMC measures, so take the following measures into consideration.



Appendix 4-4-1 Measures for control panel unit

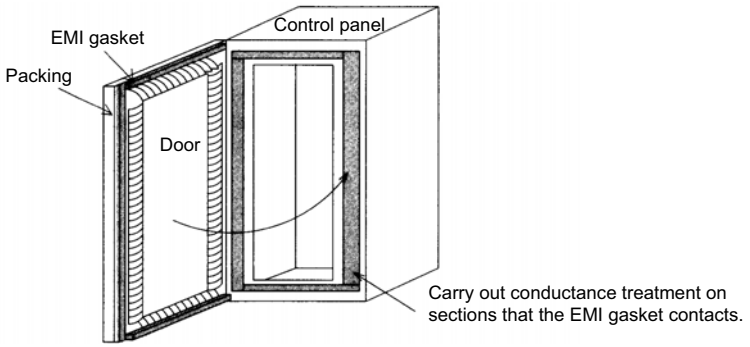
[1] Use metal for all materials configuring the panel.
[2] For the joining of the top plate and side plates, etc., mask the contact surface with paint, and fix with welding or screws.
In either case, keep the joining clearance to a max. of 20cm for a better effect.
[3] Note that if the plate warps due to the screw fixing, etc., creating a clearance, noise could leak from that place.
[4] Plate the metal plate surface (with nickel, tin) at the earthing section, such as the earthing plate.
[5] The max. tolerable hole diameter of the openings on the panel surface, such as the ventilation holes, must be 3cm to 5cm. If the opening exceeds this size, use a measure to cover it. Note that even when the clearance is less than 3cm to 5cm, noise may still leak if the clearance is long.



Appendix 4 EMC Installation Guidelines

Appendix 4-4-2 Measures for door

[1] Use metal for all materials configuring the door.
[2] Use an EMI gasket or conductive packing for the contact between the door and control panel unit.
[3] The EMI gasket or conductive packing must contact at a uniform and correct position of the metal surface of the control panel unit.
[4] The surface of the control panel unit contacted with the EMI gasket or conductive packing must have conductance treatment.
(Example) Weld (or screw) a plate that is plated (with nickel, tin).



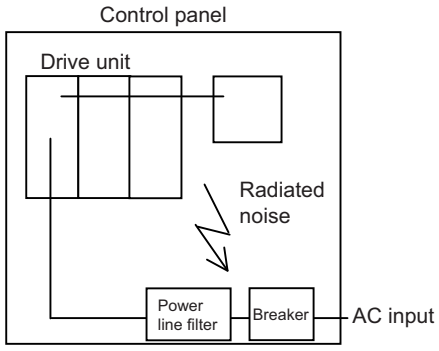
[5] As a method other than the above, the control panel unit and door can be connected with a plain braided wire. In this case, the panel and door should be contacted at as many points as possible.

Appendix 4-4-3 Measures for operation board panel

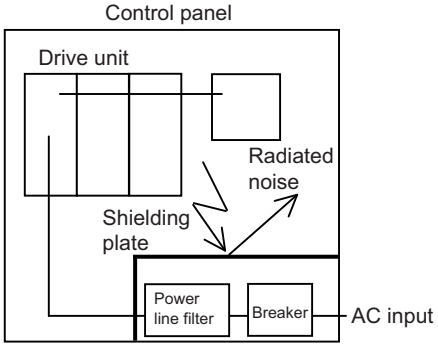
[1] Always connect the operation board and indicator with an earthing wire.
[2] If the operation board panel has a door, use an EMI gasket or conductive packing between the door and panel to provide electrical conductance in the same manner as the control panel.
[3] Connect the operation board panel and control panel with a sufficiently thick and short earthing wire.

Appendix 4-4-4 Shielding of the power supply input section

[1] Separate the input power supply section from other parts in the control panel so that the input power supply cable will not be contaminated by radiated noise.
[2] Do not lead the power line through the panel without passing it through a filter.



The power supply line noise is eliminated by the filter, but cable contains noise again because of the noise radiated in the control panel.



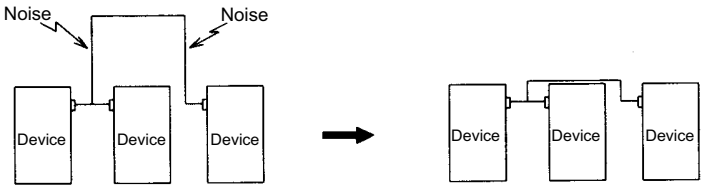
Use a metal plate, etc., for the shielding partition. Make sure not to create a clearance.

Appendix 4-5 Measures for various cables

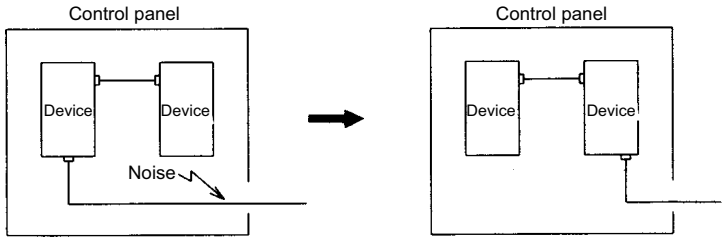
The various cables act as antennas for the noise and discharge the noise externally. Thus appropriate treatment is required to avoid the noise.
The wiring between the drive unit and motor act as an extremely powerful noise source, so apply the following measures.

Appendix 4-5-1 Measures for wiring in panel

[1] If the cables are led unnecessarily in the panel, they will easily pick up the radiated noise. Thus, keep the wiring length as short as possible.



[2] The noise from other devices will enter the cable and be discharged externally, so avoid internal wiring near the openings.



[3] Connect the control device earthing terminal and earthing plate with a thick wire. Take care to the leading of the wire.

Appendix 4-5-2 Measures for shield treatment

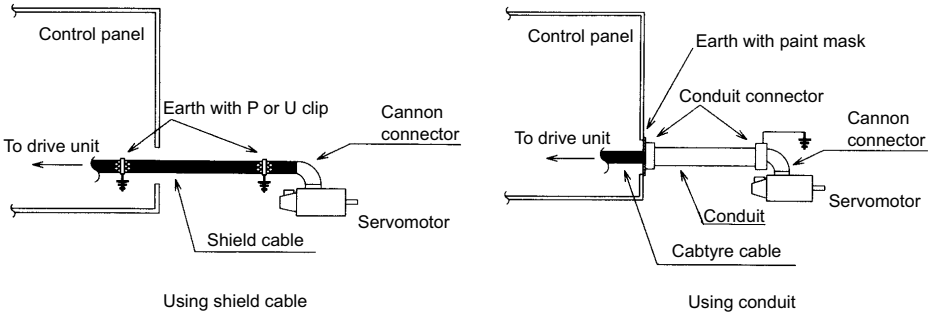
Common items

Use of shield clamp fittings is recommended for treating the shields. The fittings are available as options, so order as required. (Refer to the section "Shield clamp fitting" in this chapter.)
Clamp the shield at a position within 10cm from the panel lead out port.

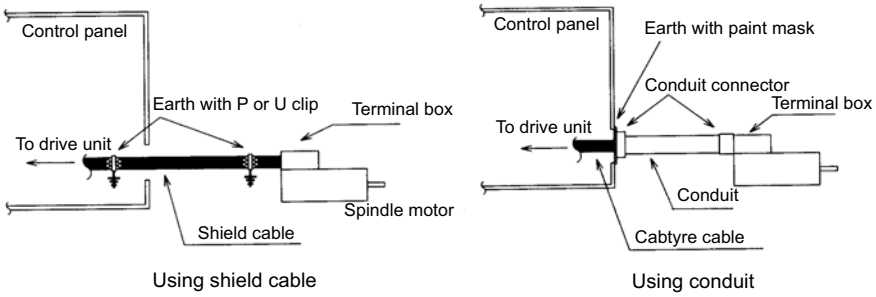
POINT

1. When leading the cables, including the grounding wire (FG), outside of the panel, clamp the cables near the panel outlet (recommendation: within 10cm).
2. When using a metal duct or conduit, the cables do not need to be clamped near the panel outlet.
3. When leading cables not having shields outside the panel, follow the instructions given for each cable. (Installation of a ferrite core, etc., may be required.)

Appendix 4-5-3 Servo/spindle motor power cable

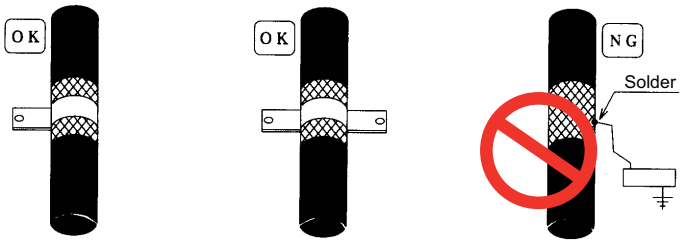


Power cable for servo motor

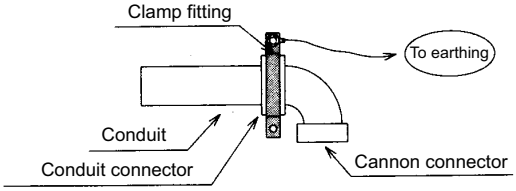


Power cable for spindle motor

[1] Use four wires (3-phase + earthing) for the power cable that are completely shielded and free from breaks.
[2] Earth the shield on both the control panel side and motor chassis side.
[3] Earth the shield with a metal P clip or U clip.
(A cable clamp fitting can be used depending on the wire size.)
[4] Directly earth the shield. Do not solder the braided shield onto a wire and earth the end of the wire.

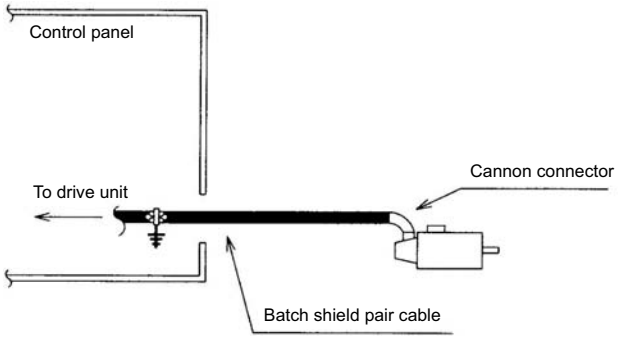


[5] When not using a shield cable for the power cable, use a conventional cabtyre cable. Use a metal conduit outside the cable.
[6] Earth the power cable on the control panel side at the contact surface of the conduit connector and control panel. (Mask the side wall of the control panel with paint.)
[7] Follow the treatment shown in the example for the conduit connector to earth the power cable on the motor side. (Example: Use a clamp fitting, etc.)



Appendix 4-5-4 Servo/spindle motor feedback cable

Use a shield pair cable for feed back cable of the servo motor to earth on NC side (inside the control panel.)
Mounting a ferrite core directly behind the unit connector is also effective in suppressing noise.

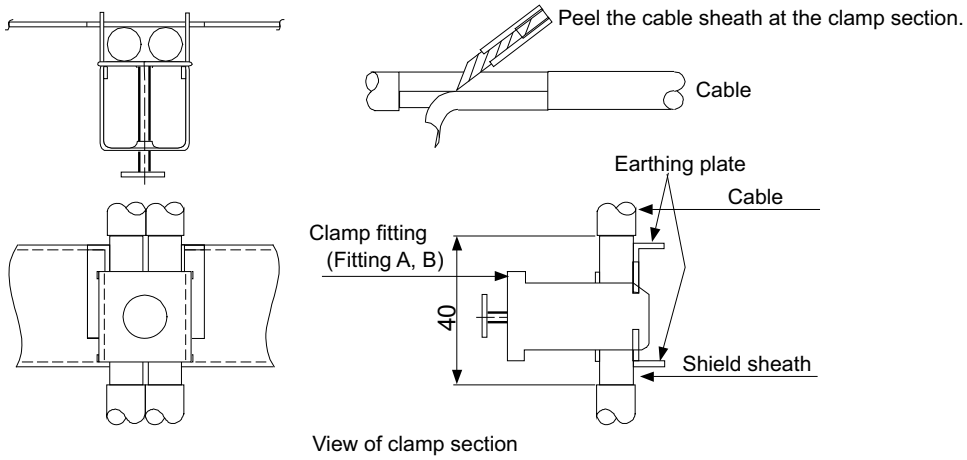


Feed back cable for servomotor

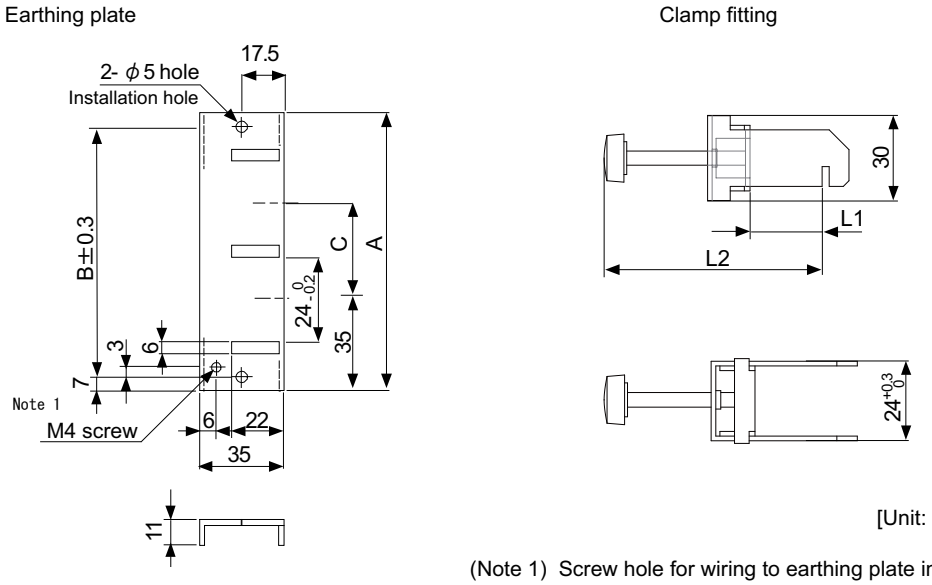
Appendix 4-6 EMC countermeasure parts

Appendix 4-6-1 Shield clamp fitting

The effect can be enhanced by connecting the cable directly to the earthing plate. Install an earthing plate near each panel's outlet (within 10cm), and press the cable against the earthing plate with the clamp fitting. If the cables are thin, several can be bundled and clamped together. Securely earth the earthing plate with the frame ground. Install directly on the cabinet or connect with an earthing wire.



・Outline drawing



[Unit: mm]

(Note 1) Screw hole for wiring to earthing plate in cabinet.
(Note 2) The earthing plate thickness is 1.6mm.

	A	B	C	Enclosed fittings
Ground Plate #D	100	86	30	Clamp fitting A x 2
Ground Plate #E	70	56	-	Clamp fitting B x 1

	L1 (maximum dimension when it is open)	L2 (reference dimension)
Clamp fitting A	25	(77)
Clamp fitting B	12	(54)

Appendix 4-6-2 Ferrite core

A ferrite core is integrated and mounted on the plastic case. Quick installation is possible without cutting the interface cable or power cable. This ferrite core is effective against common mode noise, allowing measures against noise to be taken without affecting the signal quality.

Recommended ferrite core
TDK ZCAT Series

Shape and dimensions

ZCAT type

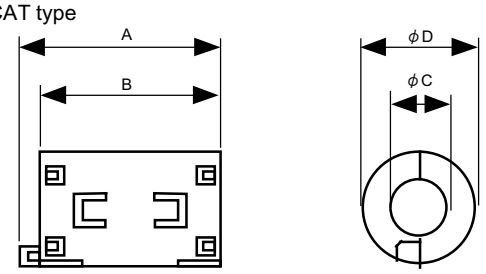


Fig.1

ZCAT-A type

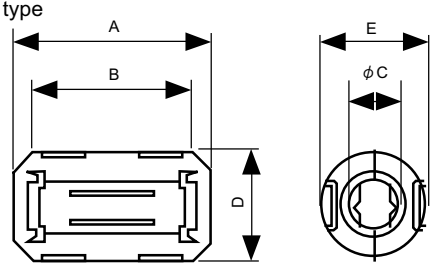


Fig.2

ZCAT-B type

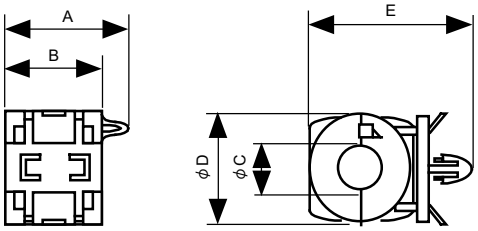


Fig.3

ZCAT-C type

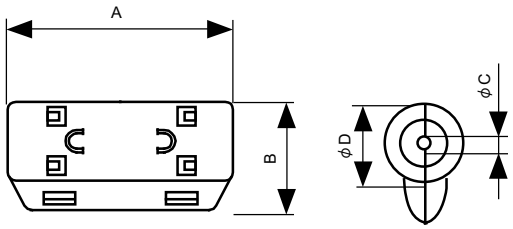


Fig.4

[Unit: mm]

Part name	Fig	A	B	C	D	E	Applicable cable outline	Mass	Recommended ferrite core
ZCAT3035-1330(-BK)*1	1	39	34	13	30	-	13	63	◎
ZCAT2035-0930-M(-BK)	2	35	29	13	23.5	22	10 to 13	29	
ZCAT2017-0930-M(-BK)	3	21	17	9	20	28.5	9	12	
ZCAT2749-0430-M(-BK)	4	49	27	4.5	19.5	-	4.5	26	

*1 A fixing band is enclosed when shipped.

ZCAT-B type: Cabinet fixed type, installation hole ø4.8 to 4.9mm, plate thickness 0.5 to 2mm

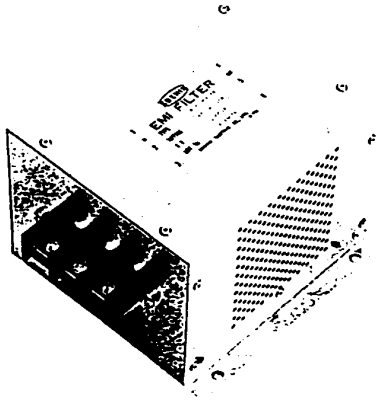
ZCAT-C type: Structured so that it cannot be opened easily by hand once closed.

Appendix 4 EMC Installation Guidelines

Appendix 4-6-3 Power line filter

< Power line filter for 200V >

HF3000A-TM Series for 200V



■Features

(a) 3-phase 3-wire type (250V series, 500V series)
(b) Compliant with noise standards German Official Notice Vfg243, EU Standards EN55011 (Class B)
(c) Effective for use with IGBT inverter and MOS-FET inverter.
(d) Easy mounting with terminal block structure, and outstanding reliability.

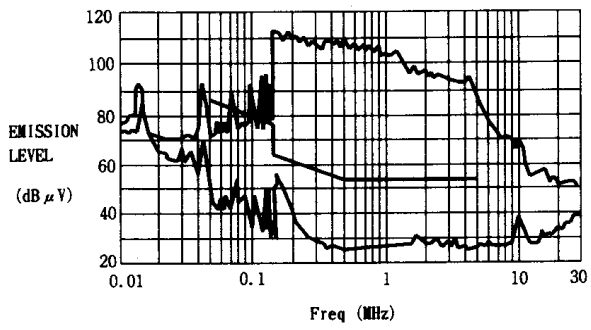
■Application

(a) Products which must clear noise standards German Official Notice Vfg243 and EU Standards EN55011 (Class B).
(b) For input of power converter using advanced high-speed power device such as IGBT MOS-FET.

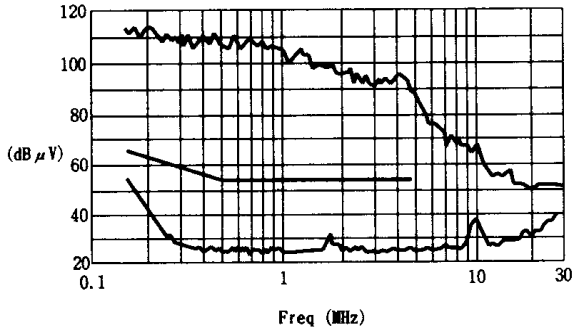
■Specifications (250V series)

Part name	HF3005A -TM	HF3010A -TM	HF3015A -TM	HF3020A -TM	HF3030A -TM	HF3040A -TM	HF3050A -TM	HF3060A -TM	HF3080A -TM	HF3100A -TM	HF3150A -TM
Rated voltage	250V AC										
Rated current	5A	10A	15A	20A	30A	40A	50A	60A	80A	100A	150A
Leakage current	1.5mA MAX 250V AC 60Hz										

<Example of measuring voltage at noise terminal>•••Measured with IGBT inverter

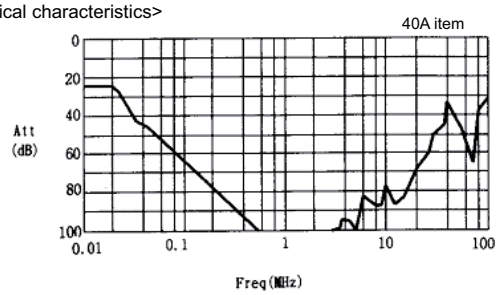


German Official Notice Vfg243 measurement data

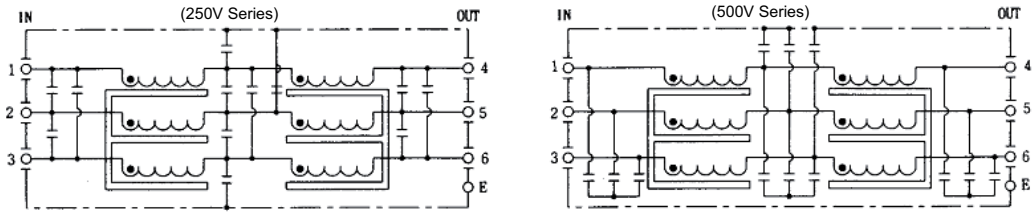


EU Standards EN55011 (Class B) measurement data

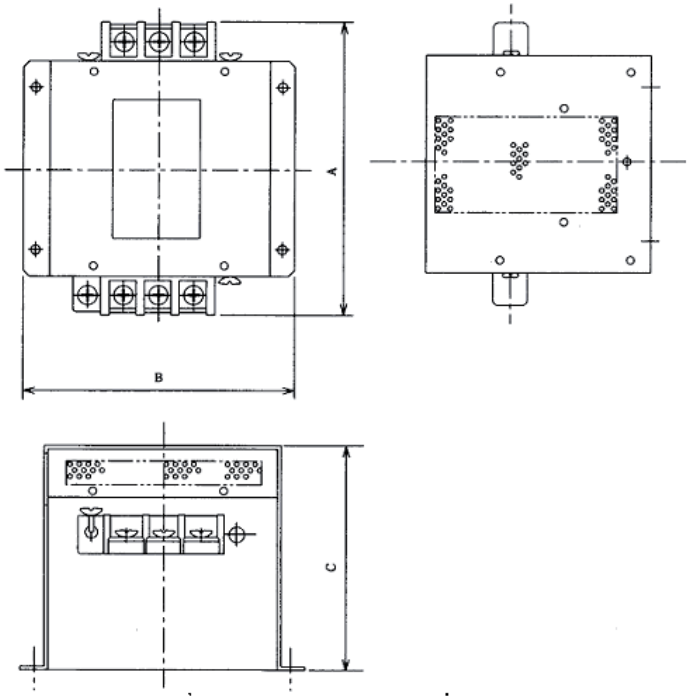
<Typical characteristics>



<Circuit diagram>



■Outline dimensions



[Unit: mm]

Model	Dimension		
	A	B	C
HF3005A-TM	180	170	130
HF3010A-TM			
HF3015A-TM			
HF3020A-TM			
HF3030A-TM	260	155	140
HF3040A-TM			
HF3050A-TM	290	190	170
HF3060A-TM			230
HF3080A-TM	405	220	210
HF3100A-TM			
HF3150A-TM	570	230	

Appendix 4 EMC Installation Guidelines

MX13 Series 3-phase high attenuation noise filter for 200V

■Features

(a) Perfect for mounting inside control panel: New shape with uniform height and depth dimensions
(b) Easy mounting and maintenance work: Terminals are centrally located on the front
(c) Complaint with NC servo and AC servo noise: High attenuation of 40dB at 150KHz
(d) Safety Standards:UL1283, CSAC22.2 No.8, EN60939(SEMKO)
(e) Patent and design registration pending

■Specifications

Item		Type			
		MX13030	MX13050	MX13100	MX13150
1	Rated voltage (AC)	3-phase 250VAC (50/60Hz)			
2	Rated current (AC)	30A	50A	100A	150A
3	Test voltage (AC for one minute across terminal and case)	2500VAC (100mA) at 25°C, 70% RH			
4	Insulation resistance (500VDC across terminal and case)	100MΩ min. at 25°C, 70% RH			
5	Leakage current (250V, 60Hz)	3.5mA max		8mA max	
6	DC resistance	30mΩ max	11mΩ max	5.5mΩ max	3.5mΩ max
7	Temperature rise	30°C max			
8	Working ambient temperature	–25°C to +85°C			
9	Working ambient humidity	30% to 95% RH (non condensing)			
10	Storage ambient temperature	–40°C to +85°C			
11	Storage ambient humidity	10% to 95% RH (non condensing)			
12	Mass (typ)	2.8kg	3.9kg	11.5kg	16kg

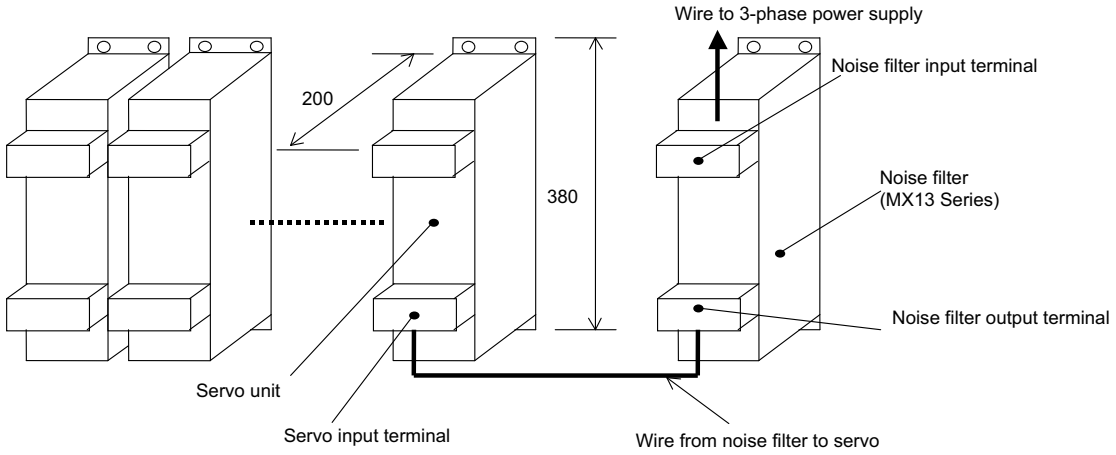
(Note) This is the value at Ta ≦ 50°C.

Refer to the following output derating for Ta > 50°C.

Contact: Densei-lambda Co., Ltd. Telephone: 03-3447-4411 (+81-3-3447-4411)
Fax: 03-3447-7784 (+81-3-3447-7784) http://www.densei-lambda.com

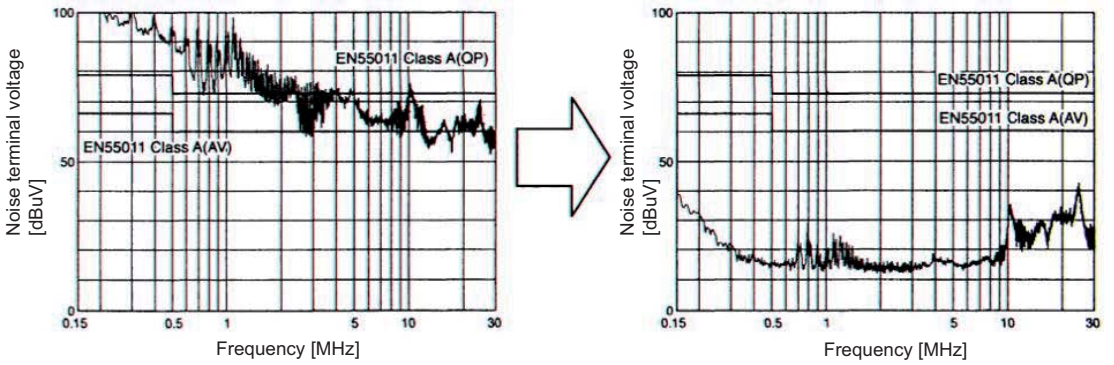
■Example of using MX13 Series

This is a noise filter with the same dimensions as the drive unit depth (200mm) and height (380mm).
This unit can be laid out easily in the device by arraigning it in a row with the servo unit.
As with the servo unit, the terminals are arranged on the front enabling ideal wire lead-out.
Refer to the following figure for details.



[Unit:mm]

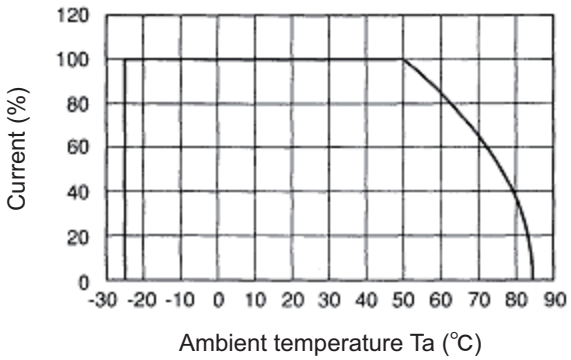
■Example of noise terminal voltage attenuation



EMI data for independent control panel
(with six-axis servo unit mounted)

EMI data for control panel + noise filter (MX13030)

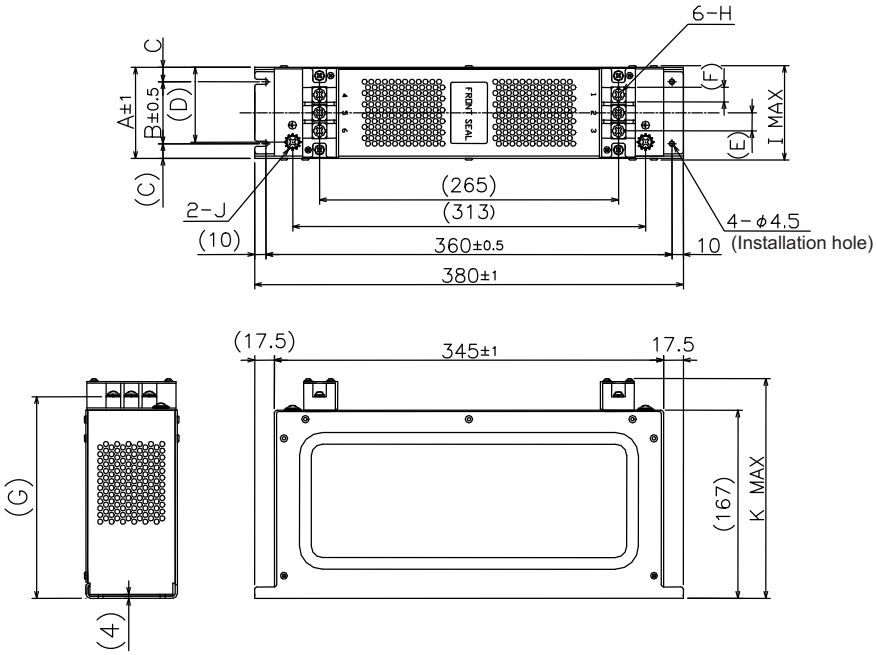
■Output derating



Appendix 4 EMC Installation Guidelines

■Outline dimension drawings

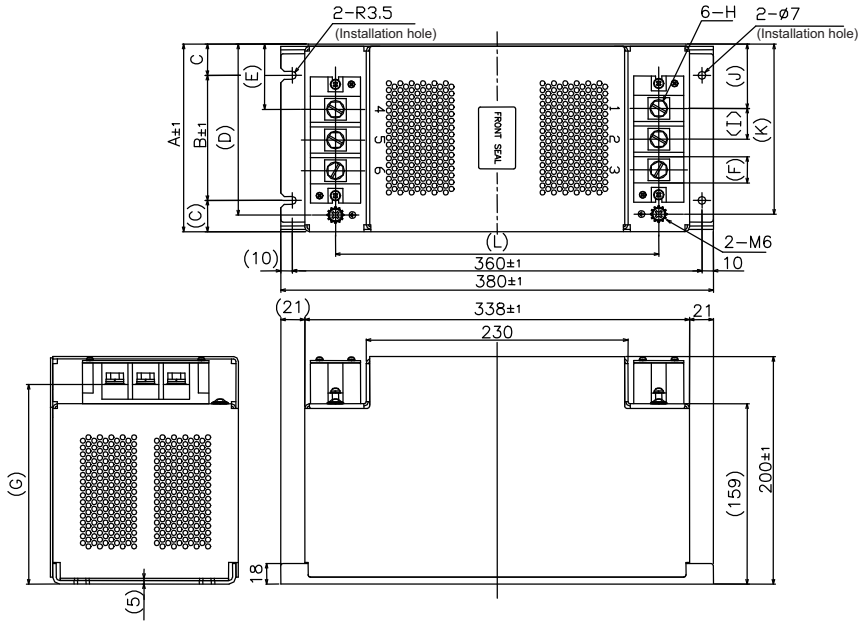
MX13030, MX13050



[Unit:mm]

	MX13030	MX13050
A	66	81
B	45	55
C	10.5	13
D	50	67
E	13	16
F	10	13
G	177	179
H	M4 screw	M6 screw
I	70	85
J	M4 screw	M6 screw
K	195	200

MX13100, MX13150



[Unit:mm]

	MX13100	MX13150
A	130	165
B	90	110
C	20	27.5
D	115	150.5
E	37.5	57.5
F	18	23
G	174	176
H	M6 screw	M8 screw
I	21	27
J	37.5	56.5
K	115	149.5
L	276	284

Appendix 4 EMC Installation Guidelines

Appendix 4-6-4 Surge protector

Insert a surge protector in the power input section to prevent damage to the control panel or power supply unit, etc. caused by the surge (lightning or sparks, etc.) applied on the AC power line.
Use a surge protector that satisfies the following electrical specifications.

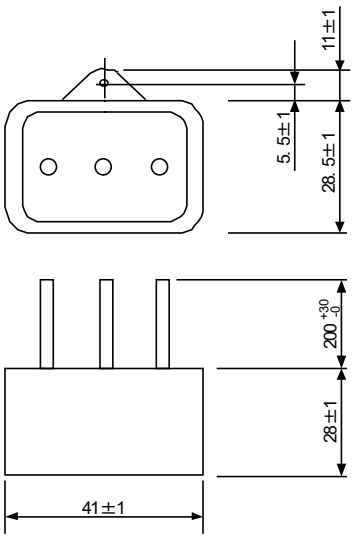
< Surge protector for 200V >

200V R•A•V-BYZ Series (for protection between lines)

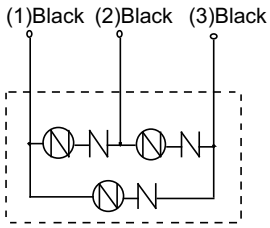
Part name	Circuit voltage 50/60Hz	Maximum tolerable circuit voltage	Clamp voltage	Surge withstand level 8/20 μs	Surge withstand voltage 1.2/50 μs	Electrostatic capacity	Service temperature
RAV-781BYZ-2	3AC 250V	300V	783V±10%	2500A	20kV	75pF	-20 to 70°C

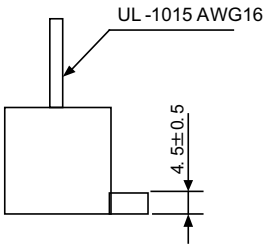
(Note) Refer to the manufacturer's catalog for details on the surge protector's characteristics and specifications.

Outline dimension drawings



Circuit diagram





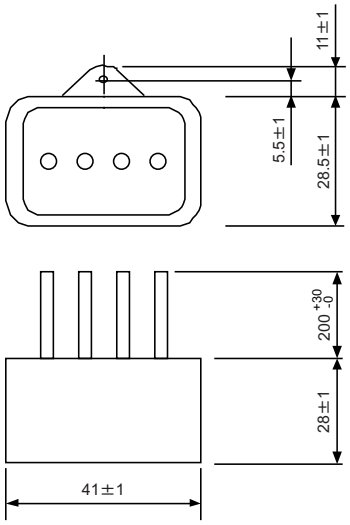
[Unit : mm]

200V R•A•V-BXZ Series (for protection between line and earth)

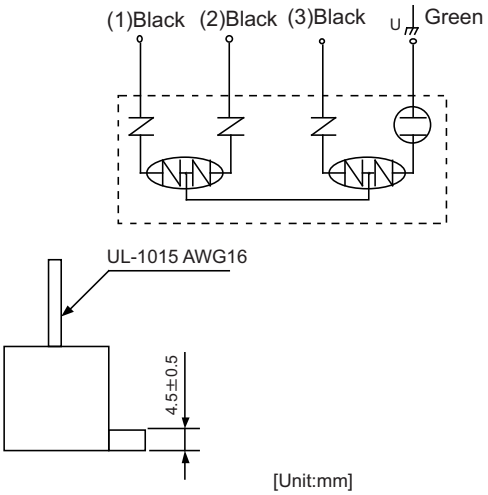
Part name	Circuit voltage 50/60Hz	Maximum tolerable circuit voltage	Clamp voltage	Surge withstand level 8/20 μs	Surge withstand voltage 1.2/50 μs	Electrostatic capacity	Service temperature
RAV-781BXZ-4	3AC 250V	300V	1700V±10%	2500A	2kV	75pF	-20 to 70°C

(Note) Refer to the manufacturer's catalog for details on the surge protector's characteristics and specifications.

Outline dimension drawings



Circuit diagram



[Unit:mm]

Appendix 4 EMC Installation Guidelines

< Surge protector for both between phases and between phase and earth >

■ Features

This surge protector can protect both between phases and between phase and earth.
This contains a fuse and has windows to check malfunction or device degradation.

■Specifications

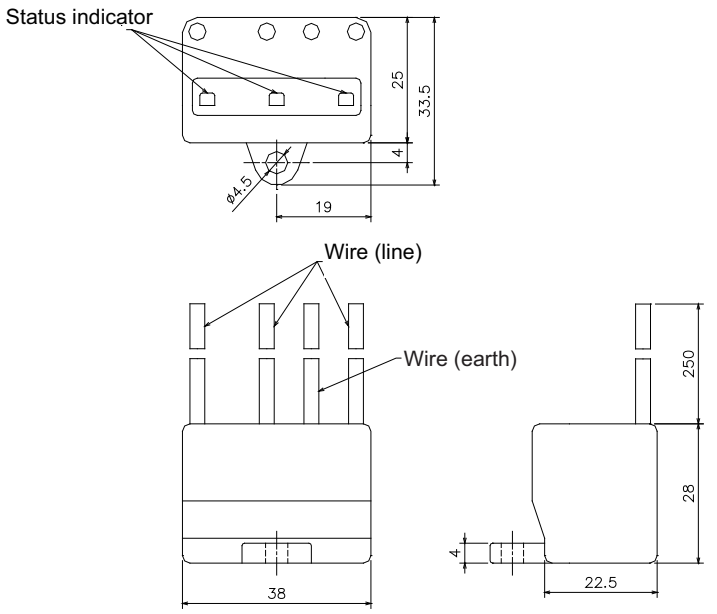
LT-C Series 200V

Part name	Circuit voltage 50/60Hz	Maximum tolerable circuit voltage	AC operation start voltage (between line and earth)	AC operation start voltage (between lines)	Voltage protection level (Up)	Nominal discharge current (8/20μs)	Maximum discharge current (8/20μs)
LT-C32G801WS	3AC 250Vrms	275Vrms	560V±20%	410V±20%	1.5kV	2500A	5000A

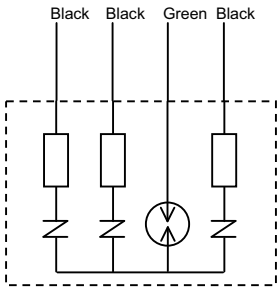
(Note) Refer to the manufacturer's catalog for details on the surge protector's characteristics and specifications, etc.

■Outline dimensions

Outline dimension drawings



Circuit diagram

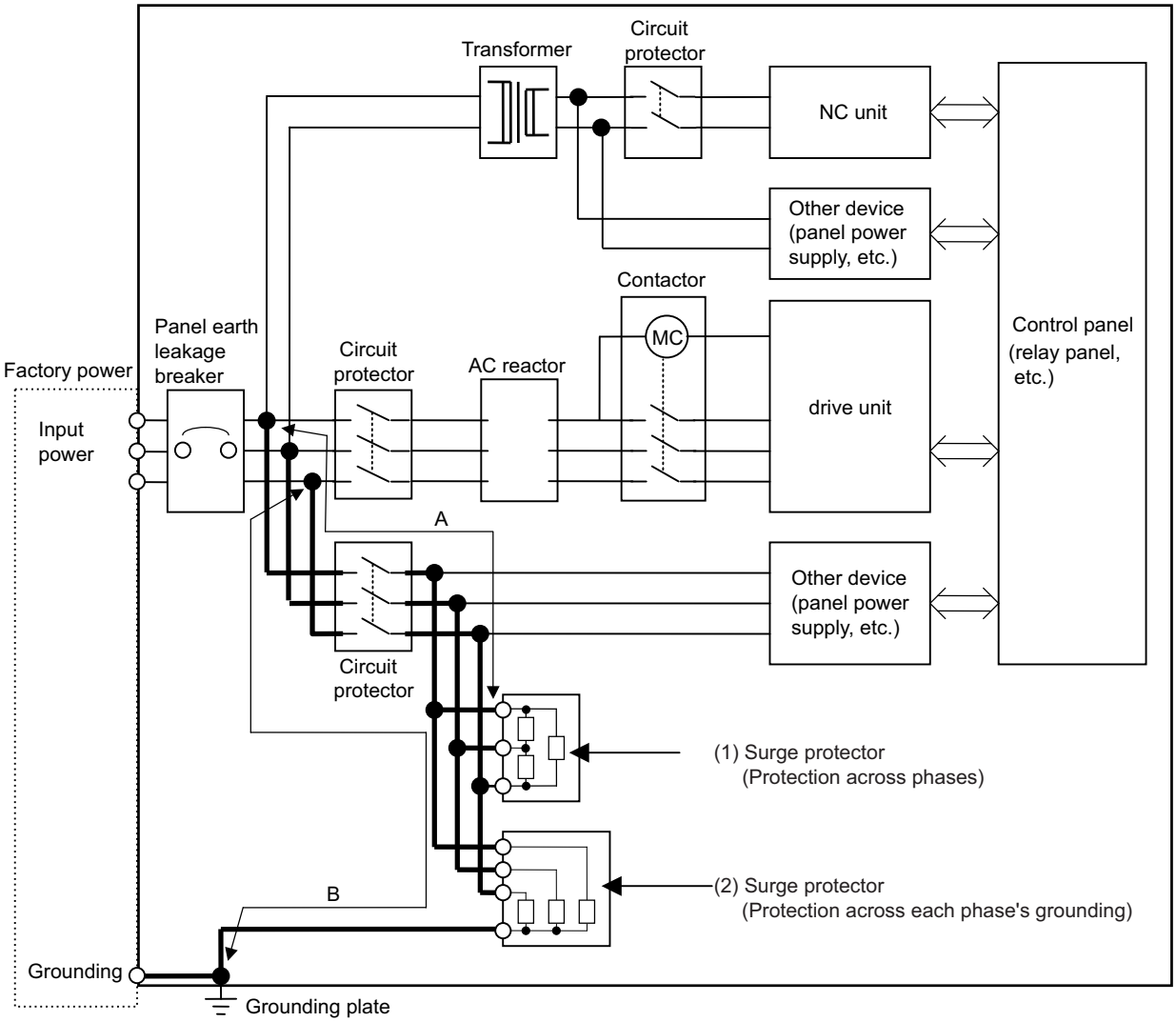


[Unit: mm]

Contact: Soshin Electric Co., Ltd. Telephone: 03-5730-8001 (+81-3-5730-8001)
http://www.soshin.co.jp

< Example of surge protector installation >

An example of installing the surge protector in the machine control panel is shown below.
A short-circuit fault will occur in the surge protector if a surge exceeding the tolerance is applied. Thus, install a circuit protector in the stage before the surge protector. Note that almost no current flows to the surge protector during normal use, so a circuit protector installed as the circuit protection for another device can be used for the surge protector.



Installing the surge absorber

CAUTION !

1. The wires from the surge protector should be connected without extensions.
2. If the surge protector cannot be installed just with the enclosed wires, keep the wiring length of A and B to 2m or less. If the wires are long, the surge protector's performance may drop and inhibit protection of the devices in the panel.
3. Surge protector to be selected varies depending on input power voltage.

Appendix 5

EC Declaration of Conformity

Contents

Appendix 5 EC Declaration of Conformity

Appendix 5-1 Compliance to EC Directives

Each series can respond to LVD and EMC directive.
Approval from a third party certification organization has been also acquired for the Low Voltage Directive.
The declaration of conformity of each unit is shown below.

Appendix 5-1-1 Low voltage equipment

MDS-D-SVJ3/SPJ3 Series

Zertifikat *Certificate*

TÜVRheinland®

Zertifikat Nr. *Certificate No.*
R 50080902

Blatt *Page*
0003

Ihr Zeichen *Client Reference*	Unser Zeichen *Our Reference*	Ausstellungsdatum	*Date of Issue* (day/mo/yr)
--	ZO-HIM- 12305023 004	13.06.2011	

Genehmigungsinhaber *License Holder*
Mitsubishi Electric Corp.
Nagoya Works
1-14, Yada-minami 5-chome
Higashi-ku, Nagoya-shi, Aichi
461-8670 JAPAN

Fertigungsstätte *Manufacturing Plant*
Mitsubishi Electric Corp.
Nagoya Works
1-14, Yada-minami 5-chome
Higashi-ku, Nagoya-shi, Aichi
461-8670 JAPAN

Prüfzeichen *Test Mark*

www.tuv.com TÜVRheinland ID:2000000000
- BAUART GEPRÜFT
- TYPE APPROVED

Geprüft nach *Tested acc. to*
EN 50178:1997

Zertifiziertes Produkt *Certified Product*	(Geräteidentifikation) *(Product Identification)*	Lizenzentgelte - Einheit *License Fee - Unit*
Steuergerät AC Servo Drive Unit		
Addition		
Type Designation :	MDS-D-SVJ3-yz	1
	MDS-D-SPJ3-yz	1
	z= blank or N	1
Rated Voltage :	3AC 200-230V, 50/60Hz (Main Power)	
	AC 200-230V, 50/60Hz (Control Power)	
Rated Current :	(see Appendix 1.2 and 1.3)	
Rated Output Values :	(see Appendix 1.2 and 1.3)	

3

TÜV Rheinland LGA Products GmbH TÜVRheinland Zertifizierungsstelle

ANLAGE (Appendix): 1.2, 1.3

Dem Zertifikat liegt unsere Prüf- und Zertifizierungsordnung zugrunde und es bestätigt die Konformität des Produktes mit den oben genannten Standards und Prüfgrundlagen. Zusätzliche Anforderungen in Ländern, in denen das Produkt in Verkehr gebracht werden soll, müssen zusätzlich betrachtet werden. Die Herstellung des zertifizierten Produktes wird überwacht.
This certificate is based on our Testing and Certification Regulation and states the conformity of the product with the standards and testing requirements as indicated above. Any additional requirements in countries where the product is going to be marketed have to be considered additionally. The manufacturing of the certified product is subject to surveillance.

Zertifizierungsstelle

TÜV Rheinland LGA Products GmbH - Tillystraße 2 - 90431 Nürnberg
Tel.: (+49/221)8 06 - 13 71 e-mail: cert-validity@de.tuv.com
Fax: (+49/221)8 06 - 39 35 http://www.tuv.com/safety

Dipl.-Ing. J. Taylor

Appendix 6

Instruction Manual for Compliance with UL/c-UL Standard

Contents

Appendix 6 Instruction Manual for Compliance with UL/c-UL

The instructions of UL/c-UL listed products are described in this manual.
The descriptions of this manual are conditions to meet the UL/c-UL standard for the UL/c-UL listed products. To obtain the best performance, be sure to read this manual carefully before use.
To ensure proper use, be sure to read specification manual, connection manual and maintenance manual carefully for each product before use.

Appendix 6-1 Operation surrounding air ambient temperature

The recognized operation ambient temperature of each unit are as shown in the table below. The recognized operation ambient temperatures are the same as an original product specification for all of the units.

Classification	Unit name	Operation ambient temperature
AC servo/spindle system	Power supply unit, AC Reactor	0 to 55°C
	Servo, Spindle drive unit	0 to 55°C
	Option unit, Battery unit	0 to 55°C
	Servo motor, Spindle motor	0 to 40°C

Appendix 6-2 Notes for AC servo/spindle system

Appendix 6-2-1 General Precaution

It takes 15 minutes maximum to discharge the bus capacitor. (The capacitor discharge time is one minute for Models MDS-D-SVJ3-03; two min. for Models MDS-D-SVJ3-04, three min. for Model MDS-D-SVJ3-07, 9 min. for Models MDS-D-SVJ3-10, -20 and -35, 10 min. for Models MDS-D/DH/DM-CV/Vx/SPx.)
When starting wiring or inspection, shut the power off and wait for more than 15 minutes to avoid a hazard of electrical shock.

Appendix 6-2-2 Installation

MDS-D/DH/DM Series are UL/c-UL listed "open type" drives and must be installed into an end-use electrical enclosure.
The minimum enclosure size is based on 150 percent of each MDS-D/DH/DM Series combination.
And also, design the enclosure so that the ambient temperature in the enclosure is 55°C (131° F) or less, refer to the specifications manual.

Appendix 6-2-3 Short-circuit ratings (SCCR)

Suitable for use in a circuit capable of delivering not more than 100kA rms symmetrical amperes, 500 volts maximum.

Appendix 6-2-4 Peripheral devices

To comply with UL/c-UL Standard, use the peripheral devices which conform to the corresponding standard.

Circuit Protector, Fuses, Magnetic contactor and AC Reactor

Applicable power supply unit	UL489 Circuit Protector	UL Fuse Class K5	Magnetic contactor (AC3)	AC Reactor
MDS-D-CV-37	20A	30A	S-N12	D-AL-7.5K
MDS-D-CV-75	40A	60A	S-N25	D-AL-7.5K
MDS-D-CV-110	60A	70A	S-N35	D-AL-11K
MDS-D-CV-185	100A	125A	S-N65	D-AL-18.5K
MDS-D-CV-300	150A	200A	S-N95	D-AL-30K
MDS-D-CV-370	200A	225A	S-N150	D-AL-37K
MDS-D-CV-450	225A	250A	S-N300	D-AL-45K
MDS-D-CV-550	300A	400A	S-N300	D-AL-55K
MDS-DH-CV-37	10A	10A	S-N12	DH-AL-7.5K
MDS-D-HCV-75	20A	25A	S-N12	DH-AL-7.5K
MDS-DH-CV-110	30A	35A	S-N21	DH-AL-11K
MDS-DH-CV-185	50A	70A	S-N25	DH-AL-18.5K
MDS-DH-CV-300	75A	110A	S-N50	DH-AL-30K
MDS-DH-CV-370	100A	125A	S-N65	DH-AL-37K
MDS-DH-CV-450	125A	150A	S-N80	DH-AL-45K
MDS-DH-CV-550	150A	200A	S-N95	DH-AL-55K
MDS-DH-CV-750	200A	300A	S-N150	DH-AL-75K

Applicable drive unit	UL 489 Circuit Protector (240Vac)	UL Fuse Class T (300Vac)	Magnetic contactor (AC3)
MDS-D-SVJ3(#)-03(##)	5A	10A	S-N12
MDS-D-SVJ3(#)-04(##)	5A	20A	S-N12
MDS-D-SVJ3(#)-07(##)	5A	20A	S-N12
MDS-D-SVJ3(#)-10(##)	10A	20A	S-N12
MDS-D-SVJ3(#)-20(##)	15A	40A	S-N21
MDS-D-SVJ3(#)-35(##)	20A	70A	S-N21
MDS-D-SPJ3(#)-075(##)	5A	15A	S-N12
MDS-D-SPJ3(#)-22(##)	15A	40A	S-N12
MDS-D-SPJ3(#)-37(##)	30A	60A	S-N21
MDS-D-SPJ3(#)-55(##)	40A	90A	S-N25
MDS-D-SPJ3(#)-75(##)	50A	125A	S-N25
MDS-D-SPJ3(#)-110(##)	75A	175A	S-N50

Circuit Protector for spindle motor Fan

Select the Circuit Protector by doubling the spindle motor fan rated.

A rush current that is approximately double the rated current will flow, when the fan is started

<Notice>

- For installation in United States, branch circuit protection must be provided, in accordance with the National Electrical Code and any applicable local codes.
- For installation in Canada, branch circuit protection must be provided, in accordance with the Canadian Electrical Code and any applicable provincial codes.

Appendix 6-2-5 Field Wiring Reference Table for Input and Output (Power Wiring)

Use the UL-approved Round Crimping Terminals to wire the input and output terminals of MDS-D/DH Series. Crimp the terminals with the crimping tool recommended by the terminal manufacturer. Please protect terminal ring by the insulation cover.
Following described crimping terminals and tools type are examples of Japan Solderless Terminal Mfg. Co., Ltd.
This wire size is each unit maximum rating. The selection method is indicated in each specification manual. (See Manual: No. IB-1500003, 1500011, 1500158, 1500875 or 1500891)

(1) Power Supply Unit (MDS-D/DH-CV)

Unit Type	**MDS-D-CV-**	37 to 75	110 to 185	300 to 450	550	
	MDS-DH-CV-	------	37 to 185	300 to 750	---	---
Terminal Screw Size	**TE2 (L+, L-)**	M6	M6	M6	M6	M10
	Torque [lb in/ N m]	35.4/4.0	<-	<-	<-	97.3/11.0
	TE3 (L11, L21)	M4	M4	M4	M4	---
	Torque [lb in/ N m]	10.6/1.2	<-	<-	<-	---
	TE1 (L1, L2, L3, ⏚)	M4	M5	M8	M10	---
	Torque [lb in/ N m]	10.6/1.2	17.7/2.0	53.1/6.0	97.3/11.0	---

TE2 (L+, L-)

Unit Type	**MDS-D-CV-**	---	37	75	110	185	---	300 to 550
	MDS-DH-CV-	37, 75	---	110	185	300, 370	450	550, 750
Wire Size (AWG) /Temp Rating Note 1		#14 /75°C	#12 /75°C	#10 /75°C	#8 /75°C	#4 /75°C	#3 /75°C	Bus-bar.
Crimping Terminals Type		R2-6	R5.5-6	R5.5-6	R8-6	R22-6	R38-6	---
Crimping Tools Type		YHT-2210	<-	<-	YPT-60-21	<-	YPT-60-21	---

TE3 (L11, L21)

Unit Type	**MDS-D/DH-CV-**	37 to 750
Wire Size (AWG) /Temp Rating Note 1		#14 /75°C
Crimping Terminals Type		R2-4
Crimping Tools Type		YHT-2210

TE1 (L1, L2, L3, ⏚)

Unit Type	**MDS-D-CV-**	37	---	75	110	185
	MDS-DH-CV-	37, 75	110	---	185	---
Wire Size (AWG) /Temp Rating Note 1		#14 /75°C	#12 /75°C	#10 /75°C	#8 /75°C	#6 /75°C
Crimping Terminals Type		R2-4	R5.5-5	5.5-S4	R8-5	R14-5
Crimping Tools Type		YHT-2210	<-	<-	YPT-60-21	<-

Unit Type	**MDS-D-CV-**	---	---	300	370, 450	550
	MDS-DH-CV-	300	370, 450	550	750	---
Wire Size (AWG) /Temp Rating Note 1		#6 /75°C	#4 /75°C	#2 /75°C	#1/0 /75°C	#3/0 /75°C
Crimping Terminals Type		R14-8	R22-8	38-S8	60-S8	80-10
Crimping Tools Type		YPT-60-21	<-	<-	<-	YPT-150-1

(Note) 75 °C:Grade heat-resistant polyvinyl chloride insulated wires (HIV).
Use copper wire only.
Above listed wire are for use in the electric cabinet on machine or equipment.

(2) Spindle Drive Unit (MDS-D/DH-SP/SP2, MDS-D-SPJ3)

Unit Type	**MDS-D-SP(#)-**	160 to 200	240 to 320	400 to 600	---	---	---
	MDS-D-SPJ3(#)-	---	---	---	22, 37(##)	22(##)	55(##) to 110(##)
	MDS-DH-SP(#)-	100 to 160	200 to 480	---	---	---	---
Terminal Screw Size	**TE2 (L+, L-)**	M6	M6	M10	---	---	---
	Torque [lb in/ N m]	35.4/4.0	<-	97.3/11.0	---	---	---
	TE3 (L11, L21)	M4	M4	M4	---	---	M3.5
	Torque [lb in/ N m]	10.6/1.2	<-	<-	---	---	<-
	TE1 (L1, L2, L3, ⏚)	M5	M8	M10	---	---	M4
	Torque [lb in/ N m]	17.7/2.0	53.1/6.0	97.3/11.0	---	---	17.7/2.0
	CNP1 (L1,L2,L3,N,P1,P2)	---	---	---	---	---	---
	and CNP3 (U,V,W))	---	---	---	5.3/0.6	---	---
	Torque [lb in/ N m]						

TE2 (L+, L-)

Wire size depends on the Power Supply Unit (MDS-D/DH-CV Series).

TE3 or CNP2 (L11, L21)

Unit Type	**MDS-D/DH-SP(#)-**	20 to 640	---
	MDS-D-SPJ3(#)-	55(##) to 110(##)	075(##) to 37(##)
Wire Size (AWG) /Temp Rating Note 1		#14 /75°C	#14 /60 or 75°C
Crimping Terminals Type		R2-4	---
Crimping Tools Type		YHT-2210	---

TE1 (U, V, W, ⏚)

Unit Type	**MDS-D-SP(#)-**	20, 40	80	160	---	200
	MDS-DH-SP(#)-	20, 40	80	100	---	160
Wire Size (AWG) /Temp Rating Note 1		#14 /75°C	#12 /75°C	#10 /75°C	#8 /75°C	#6 /75°C
Crimping Terminals Type		---	---	R5.5-5	R8-5	R14-5
Crimping Tools Type		---	---	YHT-2210	YPT-60-21	<-

Unit Type	**MDS-D-SP(#)-**	240	---	320	400	640
	MDS-DH-SP(#)-	200	320	480	---	---
Wire Size (AWG) /Temp Rating Note 1		#4 /75°C	#2 /75°C	#1/0 /75°C	#2/0 /75°C	#3/0 /75°C
Crimping Terminals Type		R22-8	38-S8	60-S8	70-10	80-10
Crimping Tools Type		YPT-60-21	YPT-60-21	<-	YPT-150-1	<-

CNP1 (L1, L2, L3), CNP3 (U, V, W) and ⏚

Unit Type	MDS-D-SPJ3(#)-	075(##) to 37(##)	55(##)	75(##)	110(##)
Wire Size (AWG) /Temp Rating Note 1		#14 /60 or 75°C	#12 /75°C	#10 /75°C	#8 /75°C
Crimping Terminals Type		---	R5.5-5	R5.5-5	R8-5
Crimping Tools Type		---	YHT-2210	<-	YPT-60-21

(Note) 75 °C:Grade heat-resistant polyvinyl chloride insulated wires (HIV).
Use copper wire only.
Above listed wire are for use in the electric cabinet on machine or equipment.

(3) Servo Drive Unit (MDS-D/DH/DM-V1/V2/V3/D-SVJ3)

Unit Type	**MDS-D-V1(#)-**	160W, 320	320W	---	---
	MDS-DH-V1(#)-	160, 160W	200	---	---
	MDS-D-SVJ3(#)-	---	---	10 to 35(##)	10(##) 20(##)
Terminal Screw Size	**TE2 (L+, L-)**	M6	M6	---	---
	Torque [lb in/ N m]	35.4/4.0	<-	---	---
	TE3 (L11, L21)	M4	M4	---	---
	Torque [lb in/ N m]	10.6/1.2	<-	---	---
	TE1 (L1, L2, L3, ⏚)	M5	M8	---	---
	Torque [lb in/ N m]	17.7/2.0	53.1/6.0	---	---
	CNP1 (L1,L2,L3,N,P1,P2) and CNP3 (U,V,W))	---	---	---	---
	Torque [lb in/ N m]	---	---	5.3/0.6	---

TE2 (L+, L-)

Wire size depends on the Power Supply Unit (MDS-D/DH-CV Series).

TE3 or CNP2 (L11, L21)

Unit Type	**MDS-D/DH/DM-V1(#)/V2(#)/V3(#)-**	10 to 320W	---
	MDS-D-SVJ3(#)-	---	03(##) to 35(##)
Wire Size (AWG) /Temp Rating Note 1		#14/75°C	#14/60 or 75°C
Crimping Terminals Type		R2-4	---
Crimping Tools Type		YHT-2210	---

TE1 (U, V, W, ⏚)

Unit Type	**MDS-D-V1(#)-**	20 to 80	160
	MDS-DH-V1(#)-	10 to 80	80W
Wire Size (AWG) /Temp Rating Note 1		#14 /75°C	#10 /75°C

Unit Type	**MDS-D-V1(#)-**	---	160W	320	320W
	MDS-DH-V1(#)-	160	160W	---	200
Wire Size (AWG) /Temp Rating Note 1		#10 /75°C	#8 /75°C	#6 /75°C	#4 /75°C
Crimping Terminals Type		R5.5-5	R8-5	R14-5	R22-8
Crimping Tools Type		YHT-2210	YPT-60-21	<-	<-

CNP1 (L1, L2, L3), CNP3 (U, V, W) and ⏚

Unit Type	**MDS-D-SVJ3(#)-**	03(##) to 20(##)	35(##)
Wire Size (AWG) /Temp Rating Note 1		#14 /60 or 75°C	#12 /60 or 75°C

(Note) 75 °C:Grade heat-resistant polyvinyl chloride insulated wires (HIV).
Use copper wire only.
Above listed wire are for use in the electric cabinet on machine or equipment.

(4) AC Reactor (D/DH-AL)

Type	**D-AL-**	7.5K, 11K	18.5K to 45K	55K
	DH-AL-	7.5K, 11K	18.5K to 75K	---
Terminal Screw Size	**L11, L12, L13, L21, L22, L23**	M5	M6	M10
	Torque [lb in/ N m]	17.7/2.0	35.4/4.0	97.3/11.0

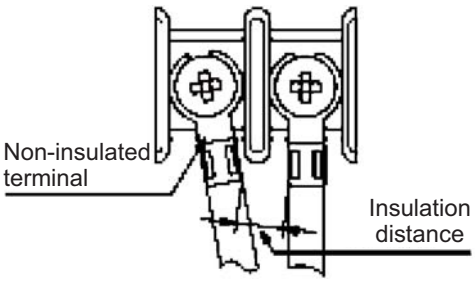
Input/Output (L11, L12, L13, L21, L22, L23)

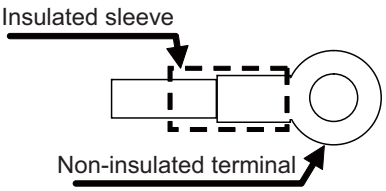
The wire connected with AC Reactor becomes same size as TE1 of the selected Power supply unit.

(5) Notes of Round Crimping Terminals and Terminal Block

The non-insulation ring tongue must have the insulated sleeving described below to prevent electric shock.

The insulated sleeve must be provided with SUMITOMO ELECTRIC FINE POLYMER INC. (File No.: E48762, Catalogue No.: SUMITUBE F(Z) or 939) per the illustration below.





Appendix 6-2-6 Motor Over Load Protection

Spindle drive unit MDS-D/DH-SP/SP2/SPJ3 and Servo drive unit MDS-D/DH/DM-V1/V2/V3/SVJ3 series have each solid-state motor over load protection. (The motor full load current is the same as rated current.) When adjusting the level of motor over load, set the parameter as follows.

(1) MDS-D/DH-SP/SP2/SPJ3 (Spindle drive unit)

Parameter No.	Parameter abbr.	Parameter Name	Setting Procedure	Standard Setting Value	Setting Range
SP021	OLT*	Overload time constant	Set the time constant for overload detection. (Unit: 1 second.)	60s	0 to 15300s
SP022	OLL	Overload detection level	Set the overload current detection level with a percentage (%) of the rating.	120%	1 to 200%

(2) MDS-D/DH/DM-V1/V2/V3/SVJ3 (Servo drive unit)

Parameter No.	Parameter abbr.	Parameter Name	Setting Procedure	Standard Setting Value	Setting Range
SV021	OLT	Overload time constant	Set the time constant for overload detection. (Unit: 1 second.)	60s	1 to 300s
SV022	OLL	Overload detection level	Set the overload current detection level with a percentage (%) of the stall rating.	150%	1 to 500%

Appendix 6-2-7 Flange of servo motor

Mount the servo motor on a flange which has the following size or produces an equivalent or higher heat dissipation effect:

Flange size (mm)	Servo Motor
	HF, HF-H, HP, HP-H, HF-KP, HF-MP, HF-SP
150x150x6	50 to 100W
250x250x6	200 to 400W
250x250x12	0.5 to 1.5kW
300x300x20	2.0 to 7.0kW
800x800x35	9.0 to 11.0kW

Appendix 6-2-8 Spindle Drive/Motor Combinations

Following combinations are the Standard combinations

Drive Unit	Rating Output (kW) of Applicable Spindle Motor
	SJ, SJ-V/VL Series Note: 1
MDS-D-SP(#)-20	0.75
MDS-D-SP(#)-40	0.75, 1.5, 2.2
MDS-D-SP(#)-80	2.2, 3.7, 7.5
MDS-D-SP(#)-160	7.5, 11
MDS-D-SP(#)-200	11, 15, 18.5
MDS-D-SP(#)-240	18.5, 22
MDS-D-SP(#)-320	22, 26, 30
MDS-D-SP(#)-400	30, 37, 45
MDS-D-SP(#)-640	37, 45, 55
MDS-D-SP2(#)-2020	0.75, 1.5 / 0.75, 1.5
MDS-D-SP2(#)-8040	2.2, 3.7, 7.5 / 0.75, 1.5, 2.2
MDS-D-SP2(#)-8080	2.2, 3.7, 7.5 / 2.2, 3.7, 7.5
MDS-D-SP2(#)-16080	7.5, 11 / 2.2, 3.7, 7.5

Drive Unit	Rating Output (kW) of Applicable Spindle Motor
	SJ-4, SJ-4-V/VL Series Note: 1
MDS-DH-SP(#)-20	0.75, 1.5, 2.2, 3.7
MDS-DH-SP(#)-40	2.2, 3.7, 5.5, 7.5
MDS-DH-SP(#)-80	2.2, 3.7, 7.5, 11
MDS-DH-SP(#)-100	7.5, 11, 15, 18.5
MDS-DH-SP(#)-160	18.5, 22, 26, 30
MDS-DH-SP(#)-200	26, 30, 37, 45
MDS-DH-SP(#)-320	30, 37, 45, 55
MDS-DH-SP(#)-480	45, 55, 60
MDS-D-SP2(#)-2020	0.75, 1.5, 2.2, 3.7 / 0.75, 1.5, 2.2, 3.7
MDS-D-SP2(#)-4040	2.2, 3.7, 5.5, 7.5 / 2.2, 3.7, 5.5, 7.5
MDS-D-SP2(#)-8040	2.2, 3.7, 7.5, 11 / 2.2, 3.7, 5.5, 7.5

(Note) Applicable unit depends on the range of power constant of motor.Inquire of Mitsubishi about the detail of the combinations.

Drive Unit	Spindle Motor	
	SJ-V	SJ-VL
MDS-D-SPJ3(#)-075(##)	-	SJ-VL0.75
MDS-D-SPJ3(#)-22(##)	SJ-V2.2	SJ-VL1.5, SJ-VL2.2
MDS-D-SPJ3(#)-37(##)	SJ-V3.7	-
MDS-D-SPJ3(#)-55(##)	SJ-V5.5	-
MDS-D-SPJ3(#)-75(##)	SJ-V7.5	-
MDS-D-SPJ3(#)-110(##)	SJ-V11	-

Appendix 6-2-9 Servo Drive/Motor Combinations

Following combinations are the Standard combinations

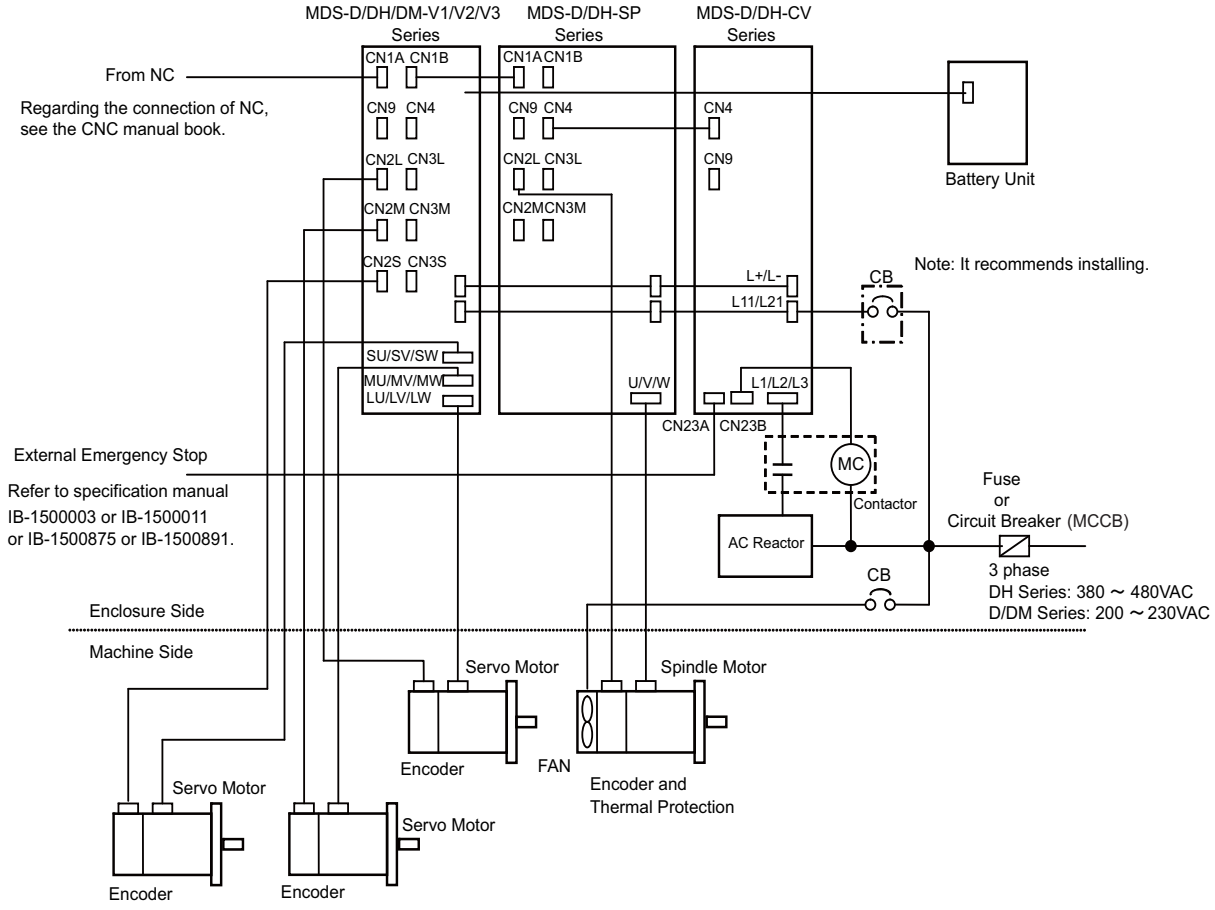
Drive Unit	Servomotor			
	HF-KP	HF-SP	HF-MP	HF
MDS-D-SVJ3(#)-03(##)	053, 13, 23	-	053, 13, 23	-
MDS-D-SVJ3(#)-04(##)	43	-	43	-
MDS-D-SVJ3(#)-07(##)	73	51, 52	73	54
MDS-D-SVJ3(#)-10(##)	-	81, 102	-	75, 104, 105
MDS-D-SVJ3(#)-20(##)	-	121, 152, 201, 202	-	154, 204
MDS-D-SVJ3(#)-35(##)	-	352	-	354

(Note #: may be followed by S)
(Note ##: may be followed by N or NA)

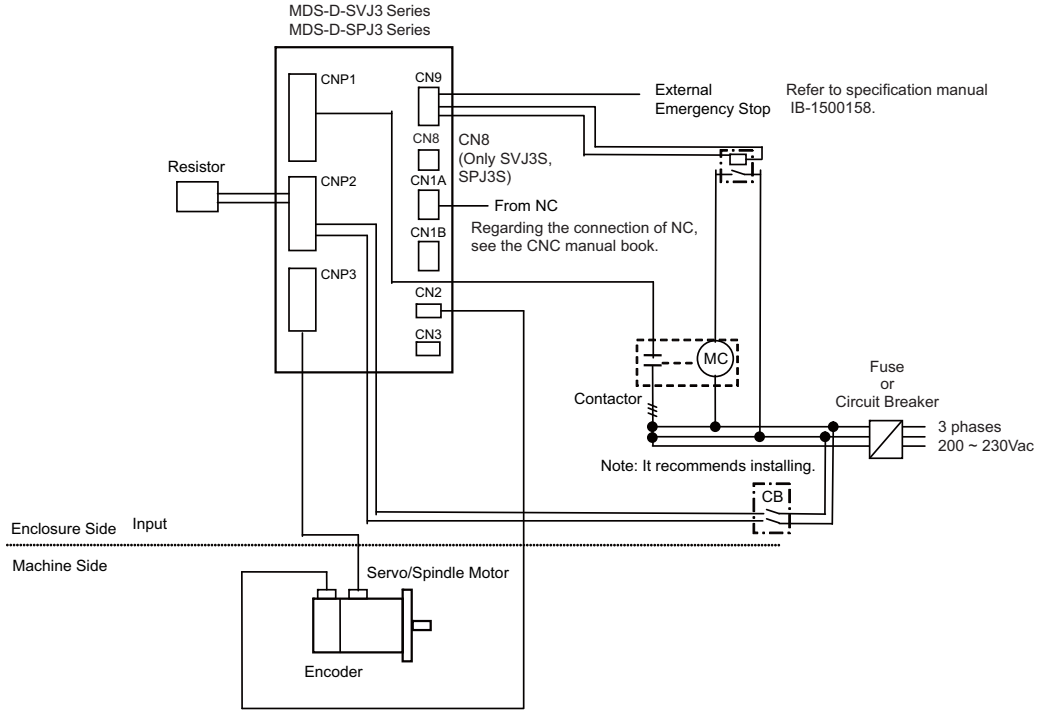
(Note) Our drive system complies with UL508C（Power Conversion Equipment), but accessory products (motor, AC reactor, regenerative resistor, etc.) excluding drive units are not provided with UL marking (Listed 88R2) for UL580C.
However, the safety of these accessory products including the motors has been confirmed by UL Follow-Up Service.

Appendix 6-3 AC Servo/Spindle System Connection

Appendix 6-3-1 MDS-D/DH/DM-Vx/SP Series



Appendix 6-3-2 MDS-D-SVJ3/SPJ3 Series



Appendix 7

Compliance with Restrictions in China

Contents

Appendix 7 Compliance with Restrictions in China

Appendix 7-1 Compliance with China CCC certification system

Appendix 7-1-1 Outline of China CCC certification system

The Safety Certification enforced in China included the "CCIB Certification (certification system based on the "Law of the People's Republic of China on Import and Export Commodity Inspection" and "Regulations on Implementation of the Import Commodities Subject to the Safety and Quality Licensing System" enforced by the State Administration of Import and Export Commodity Inspection (SACI) on import/export commodities, and the "CCEE Certification" (certification system based on "Product Quality Certification Management Ordinance" set forth by the China Commission for Conformity Certification of Electrical Equipment (CCEE) on commodities distributed through China.
CCIB Certification and CCEE Certification were merged when China joined WTO (November 2001), and were replaced by the "China Compulsory Product Certification" (hereinafter, CCC Certification) monitored by the State General Administration of Quality Supervision, Inspection and Quarantine (AQSIQ) of the People's Republic of China.
The CCC Certification system was partially enforced from May 2002, and was fully enforced from May 2003. Target commodities which do not have CCC Certification cannot be imported to China or sold in China.
(Indication of the CCIB or CCEE mark has been eliminated from May 1, 2003.)

CCIB: China Commodity Inspection Bureau
CCEE: China Commission for Conformity Certification of Electrical Equipment
CCC: China Compulsory Certification

Appendix 7-1-2 First catalogue of products subject to compulsory product certification

The First Catalogue of Products subject to Compulsory Product Certification, covering 132 items (19 categories) based on the CCIB products (104 items), CCEE products (107 items) and CEMC products (Compulsory EMC Certification products) was designated on December 3, 2001.

<table>
<tr><th>Class</th><th colspan="3">Product catalogue</th><th>Class</th><th colspan="2">Product catalogue</th></tr>
<tr><td>1</td><td colspan="3">Electric Wires and Cables (5 items)</td><td>5</td><td>Electric tools</td><td>(16 items)</td></tr>
<tr><td>2</td><td colspan="3">Switches, Installation protective and connection devices (6 items)</td><td>6</td><td>Welding machines</td><td>(15 items)</td></tr>
<tr><td rowspan="20">3</td><td colspan="2">Low-voltage Electrical Apparatus (9 items)</td><td>Compulsory Certification Regulations</td><td>7</td><td>Household and similar electrical appliances</td><td>(18 items)</td></tr>
<tr><td rowspan="19"></td><td>Circuit-breakers (including RCCB, RCBO, MCB)</td><td rowspan="19">CNCA -01C -011: 2001 (Switch and Control Equipment)
CNCA -01C -012: 2001 (Installation Protective Equipment)</td><td>8</td><td>Audio and video equipment</td><td>(16 items)</td></tr>
<tr><td>Low-voltage switchers (disconnectors, switch-disconnectors, and fuse-combination devices.</td><td>9</td><td>Information technology equipment</td><td>(12 items)</td></tr>
<tr><td>Other protective equipment for circuits (Current limiting devices, circuits protective devices, over current protective devices, thermal protectors, over load relays, low-voltage electromechanical contactors and motor starters)</td><td>10</td><td>Lighting apparatus</td><td>(2 items)</td></tr>
<tr><td>Relays (36V < Voltage ≦ 1000V)</td><td>11</td><td>Telecommunication terminal equipment</td><td>(9 items)</td></tr>
<tr><td>Other switches (Switches for appliances, vacuum switches, pressure switches, proximity switches, foot switches, thermal sensitive switches, hydraulic switches, push-button switches, position limit switches, micro-gap switches, temperature sensitive switches, travel switches, change-over switches, auto-change-over switches, knife switches)</td><td>12</td><td>Motor vehicles and Safety Parts</td><td>(4 items)</td></tr>
<tr><td>Other devices (contactors, motor starters, indicator lights, auxiliary contact assemblies, master controllers, A.C. Semiconductor motor controllers and starters)</td><td>13</td><td>Tyres</td><td>(4 items)</td></tr>
<tr><td>Earth leakage protectors</td><td>14</td><td>Safety Glasses</td><td>(3 items)</td></tr>
<tr><td>Fuses</td><td>15</td><td>Agricultural Machinery</td><td>(1 item)</td></tr>
<tr><td>Low-voltage switchgear</td><td>CNCA-01C-010:2001 (Low-voltage switchgear)</td><td>16</td><td>Latex Products</td><td>(1 item)</td></tr>
<tr><td></td><td></td><td>17</td><td>Medical Devices</td><td>(7 items)</td></tr>
<tr><td></td><td></td><td>18</td><td>Fire Fighting Equipment</td><td>(3 items)</td></tr>
<tr><td></td><td></td><td>19</td><td>Detectors for Intruder Alarm Systems</td><td>(1 item)</td></tr>
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<tr><td>4 (Note)</td><td colspan="2">Small power motors (1 item)</td><td>CNCA-01C-013:2001 (Small power motors)</td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td></td><td></td></tr>
</table>

(Note) When the servomotor or the spindle motor of which output is 1.1kW or less (at 1500 r/min) is used, NC could have been considered as a small power motor. However, CQC (China Quality Certification Center) judged it is not.

Appendix 7 Compliance with Restrictions in China

Appendix 7-1-3 Precautions for shipping products

As indicated in Appendix 7-1-2, NC products are not included in the First Catalogue of Products subject to Compulsory Product Certification. However, the Customs Officer in China may judge that the product is subject to CCC Certification just based on the HS Code.(Note2)
NC cannot be imported if its HS code is used for the product subject to CCC Certification. Thus, the importer must apply for a "Certification of Exemption" with CNCA.(Note3) Refer to Appendix 7-1-4. Application for Exemption for details on applying for an exemption.

(Note 1) The First Catalogue of Products subject to Compulsory Product Certification (Target HS Codes) can be confirmed at http://www.cqc.com.cn/Center/html/60gonggao.htm.
(Note 2) HS Code: Internationally unified code (up to 6 digits) assigned to each product and used for customs.
(Note 3) CNCA: Certification and Accreditation Administration of People's Republic of China (Management and monitoring of certification duties)

Appendix 7-1-4 Application for exemption

Following "Announcement 8" issued by the Certification and Accreditation Administration of the People's Republic of China (CNCA) in May 2002, a range of products for which application for CCC Certification is not required or which are exempt from CCC marking has been approved for special circumstances in production, export and management activities.
An application must be submitted together with materials which prove that the corresponding product complies with the exemption conditions. Upon approval, a "Certification of Exemption" shall be issued.

<Range of products for which application is exempt>

Range of products not requiring application

(a) Items brought into China for the personal use by the foreign embassies, consulates, business agencies and visitors
(Excluding products purchased from Service Company for Exporters)
(b) Products presented on a government-to-government basis, presents
(c) Exhibition products (products not for sale)
(d) Special purpose products (e.g., for military use)
Products not requiring application for CCC Certification are not required to be CCC marked or certified.

Range of products for which application is exempted

(e) Products imported or manufactured for research and development and testing purposes
(f) Products shipped into China for integration into other equipment destined for 100% re-export to a destination outside of China
(g) Products for 100% export according to a foreign trade contract (Excluding when selling partially in China or re-importing into China for sales)
(h) Components used for the evaluation of an imported product line
(i) The products imported or manufactured for the service (service and repairs) to the end-user. Or the spare parts for the service (service and repairs) of discontinued products.
(j) Products imported or manufactured for research and development, testing or measurements
(k) Other special situations

The following documents must be prepared to apply for an exemption of the "Import Commodity Safety and Quality License" and "CCC Certification".

(1) Formal Application
  (a) Relevant introduction and description of the company.
  (b) The characteristics of the products to be exempted.
  (c) The reason for exemption and its evidence (ex. customs handbook).
  (d) The name, trademark, quantity, model and specification of the products to be exempted. (Attach a detail listing of these items for a large quantity of products. When importing materials for processing and repair equipments, submit a list of the importing materials for each month and repair equipments.)
  (e) Guarantee for the safety of the products; self-declaration to be responsible for the safety during the manufacturing and use.
  (f) To be responsible for the authenticity and legitimacy of the submitted documents. Commitment to assist CNCA to investigate on the authenticity of the documents (When CNCA finds it necessary to investigate on the authenticity of the documents.)
(2) Business license of the company (Copy)
(3) Product compliance declaration
  Indicate which standard’s requirements the products comply with or submit a test report (Copy is acceptable. The report can be prepared in a manufacturer’s laboratory either at home or overseas.)
(4) Import license (Only if an import license is needed for this product. Copy is acceptable.)
(5) Quota certificate (Only if a quota certificate is needed for this product. Copy is acceptable.)
(6) Commercial contract (Copy is acceptable.)
(7) If one of item (4), (5) or (6) cannot be provided, alternative documents, such as bill of lading, the invoice, and other evidential documents must be submitted.

Appendix 7 Compliance with Restrictions in China

Appendix 7-1-5 Mitsubishi NC product subject to/not subject to CCC certification

The state whether or not Mitsubishi NC products are subject to the CCC Certification is indicated below, based on the "First Catalogue of Products subject to Compulsory Product Certification" issued by the State General Administration of Quality Supervision, Inspection and Quarantine (AQSIQ) of the People's Republic of China and the Certification and Accreditation Administration of the People's Republic of China (CNCA) on July 1, 2002.

Model	China HS Code (Note 1)	Judgment on whether or not subject to CCC Certification
Power supply unit **Servo/spindle drive unit**	85044090 85371010	Not subject to CCC Certification
Servo/spindle	85015100 85015200	Not subject to CCC Certification
NC	-	Not subject to CCC Certification
Display unit	-	Not subject to CCC Certification

(Note 1) The China HS Code is determined by the customs officer when importing to China. The above HS Codes are set based on the HS Codes used normally when exporting from Japan.

(Note 2) Reference IEC Standards are used as the actual IEC Standards may not match the GB Standards in part depending on the model.

Whether or not the NC products are subject to CCC Certification was judged based on the following five items.

(a) Announcement 33 (Issued by AQSIQ and CNCA in December 2001)

(b) HS Codes for the products subject to CCC Certification (Export Customs Codes)
* HS Codes are supplementary materials used to determine the applicable range. The applicable range may not be determined only by these HS Codes.

(c) GB Standards (This is based on the IEC Conformity, so check the IEC. Note that some parts are deviated.)

(d) Enforcement regulations, and products specified in applicable range of applicable standards within

(e) "Products Excluded from Compulsory Certification Catalogue" (Issued by CNCA, November 2003)

Reference

- Outline of China's New Certification System (CCC Mark for Electric Products), Japan Electrical Manufacturers' Association
- Outline of China's New Certification System (CCC Mark for Electric Products) and Electric Control Equipment, Nippon Electric Control Equipment Industries Association

Appendix 7-2 Response to the China environment restrictions

Appendix 7-2-1 Outline of the law on the pollution prevention and control for electronic information products

Ministry of Information Industry (information industry ministry) issued this law on Feb.28, 2006 (Note) (effective from Mar.1, 2007.) in order to protect the environment and the health of the people with restricting and reducing the environmental pollution caused by the electronic information product wastes. The restrictions are applied to containing lead (Pb), hydrargyrum (Hg), cadmium (Cd), hexavalent chromium (Cr (VI)), polybrominated biphenyl (PBB) and polybrominated diphenyl ether (PBDE) in two stages.

(Note)For the details, refer to the following.

http://www.mii.gov.cn/art/2006/03/02/art_524_7343.html

(1) First stage: Requirement of indicating contained substance

The producer and importer of the electronic information product are required to indicate the hazardous substance. The concrete categories of the products belonging in the following eleven main categories are described as subjected product list (electronic information product category note).

• Radar device • Communication device • Radio/TV device industry product • Computer product
• Consumer-electronics device • Electronic measuring apparatus
• Electronics industry dedicated device • Electronic parts • Electronics device
• Electronics application product • Electronics dedicated material

(2) Second stage: Suppressing the amount of contained substances and compulsory CCC Certification

The product listed in the “Electronic information product pollution priority control list” cannot be sold in China unless it conforms to the Compulsory Product Certification System (CCC Certification) and its cadmium usage is suppressed to 0.01w% and other substances usage less than 0.1w%. Note that the timing when this is effective is unmentioned.

Appendix 7-2-2 Response to the drive product for Mitsubishi NC

The drive product for NC has no items falling under the subjected product list (electronic information product category note). However, for use with the drive product included in the subjected product or for treating the product properly, information based on the law on the pollution prevention and control for electronic information products” are described in the section “Appendix 7-2-3” for reference.

Appendix 7 Compliance with Restrictions in China

Appendix 7-2-3 Indication based on “Pollution suppression marking request for electronic information product”

(1) Electronic information product pollution suppression marking

Note: This symbol mark is for China only.
This marking indicates the environmental protection expiration date applied to the electronic information products sold in China according to the law on the pollution prevention and control for electronic information products issued on Feb.28, 2006. As long as you keep safety for this product and follow the precautions for use, there are no serious effects on the environment pollution, human body or property within its term reckoned from the manufacturing date.

(Note) Equate the environmental protection expiration date of consumables, such as enclosed battery and cooling fan, with the product life. When disposing the product after using it properly, obey each local laws and restrictions for collecting and recycling of the electronic information product.

(2) The names of contained six hazardous substances and the parts containing them

The names of six substances contained in this product and the parts containing them are shown below.

Parts name	Toxic/hazardous substance or element					
	Lead (Pb)	Hydrargyrum (Hg)	Cadmium (Cd)	Hexavalent chromium (Cr(VI))	(PBB)	(PBDE)
Drive unit	-	**	**	**	**	**
Servo motor/spindle motor	-	**	**	**	**	**
Dedicated options (cable/connector)	-	**	**	-	**	**
Dedicated Options (detector/AC reactor)	-	**	**	-	**	**
Dedicated Options (battery)	-	**	**	**	**	**

**: This mark means that toxic/hazardous substance content in all homogeneous materials of corresponding parts does not exceed the standard specified in the standard of SJ/T11363-2006.

-: This mark means that toxic/hazardous substance content in the homogeneous materials of corresponding parts exceeds the standard specified in the standard of SJ/T11363-2006.

Revision History

Date of revision	Manual No.	Revision details
Jun. 2006	IB(NA)1500158-A	First edition created.
Jan. 2011	IB(NA)1500158-B	- "Outline for MDS-D-SVJ3/SPJ3 Series Instruction Manual (IB-1500193-C)" was added. - The following servomotors were added. HF224, HF123, HF223, HF303, HF142, HF302, HF-KP13, HF-KP23, HF-KP43, HF-KP73 - SJ-D Series and SJ-DJ Series were added. - Specifications list of servomotor and spindle motor were revised. - List of servo drive unit and spindle drive unit were revised. - Descriptions for tool spindle motor was added. - "Unit outline dimension drawing" was added. - "Function specifications" (function specifications list and explanation of each function) were added. - "Machine accuracy" and "Flange of servo motor" were added. - "Sony Manufacturing Systems Corporation" was changed to "Magnescale Co., Ltd". - The following spindle options were added. TS5690, MU1606 Series, ERM280, MPCI Series - The following detector interface units were added. IBV Series, EIB192M, EIB392M, ADB-20J Series - Optical communication repeater unit (FCU7-EX022) was added. - List of regenerative option was revised. - Input and output circuit diagram were added to "Relay". - "Selection of the servomotor" and "Selection of the regenerative resistor" were revised. - DI/O or maintenance connector was added. - "Cable and connector assembly" was deleted. - "Restrictions for Lithium Batteries" was revised. - "Compliance to EC Directives" was revised. - "EMC Installation Guidelines" was revised. - "EC Declaration of conformity" was revised. - "Instruction Manual for Compliance with UL/c-UL Standard" was revised. - "Grobal Service Network" was revised. - The outline dimension drawings were deleted form this manual. For the outline dimension drawings, refer to "DRIVE SYSTEM DATA BOOK (IB-1500273(ENG))". - Miswrite is corrected.

Date of revision	Manual No.	Revision details
Jan. 2011	IB(NA)1500158-C	- Descriptions related to the unit type followed by "NA" were added. (SVJ3-10NA/20NA, SPJ3-22NA: The connector for CNP1,2 and 3 was changed.) - "Precautions for safety" was revised. - "System configuration" was revised. - "Servomotor type" was revised. - Notes were added to "Spindle motor type". - "Tool spindle motor type" was revised. - "Explanation of each part" was revised. - Function specifications list was revised. - "High frequency current control" was deleted. - Overload protection characteristics for HF105 was revised. - A caution was added to "Shaft characteristics" in "Spindle motor". - "Servo options" and "Battery option" were revised. - "MDS-BTBOX-36" was added. - "Spindle options" was revised. - "Spindle side ABZ pulse output detector (OSE-1024-3-15-68, OSE-1024-3-15-68-8)" was replaced by "Spindle side ABZ pulse output detector (OSE-1024 Series)". - "(MITSU02-4)" was added to EIB192M and EIB392M. - "Optical communication repeater unit (FCU7- EX022)" was revised. - "Cable connection diagram" was revised. - "List of cable and connectors" and "Relay" were revised. - "Selection of circuit protector and contactor" was revised. - "Cable and Connector Specifications" was revised. - "EC Declaration of Conformity" was revised. - "Instruction Manual for Compliance with UL/c- UL Standard" was revised - "Global service network" was revised. - Miswrite is corrected.

Global Service Network

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Notice

Every effort has been made to keep up with software and hardware revisions in the contents described in this manual. However, please understand that in some unavoidable cases simultaneous revision is not possible.
Please contact your Mitsubishi Electric dealer with any questions or comments regarding the use of this product.

Duplication Prohibited

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MODEL	MDS-D-SVJ3/SPJ3 Series
MODEL CODE	008-384
Manual No.	IB-1500158

IB(NA)1500158(ENG)-C(1109)MEE
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